Soil Survey

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Kitsap County Washington

By
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and
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Washington Agricultural Experiment Station

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
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Washington Agricultural Experiment Station and
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SOIL SURVEY OF KITSAP COUNTY, WASHINGTON

By ROBERT WILDERMUTH, in Charge, and S. O. PERKINS, United States Department of Agriculture, and R. E. PASCO, and EDGAR H. HUBBARD
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COUNTY SURVEYED

Kitsap County is located in the Puget Sound Basin in the western part of Washington (fig. 1). Port Orchard, the county seat, is about 14 miles southwest of Seattle. The county is a long narrow irregular-shaped part of Kitsap Peninsula which projects into Puget Sound. It is indented by many bays or inlets that form a very long and irregular coast line. All, except the southern part, is bounded by waters of the sound. Parts of Mason and Pierce Counties join its southern boundary, and a part of Puget Sound defines its irregular shore line on the east and north. Hood Canal, a long arm of Puget Sound, forms the western boundary. In addition to the mainland, the county embraces Bainbridge and Blake Islands. The former, with an area of about 28 square miles, lies east of the mainland and is separated from it by Agate Passage, Port Orchard (inlet), and Rich Passage. Blake Island, including an area of only about 1 square mile, is 2 miles east of Colby. The land area of the county is 394 square miles, or 252,160 acres.

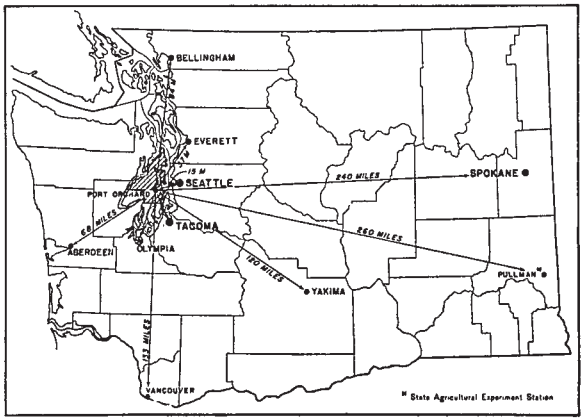

FIGURE 1.—Sketch map showing location of Kitsap County, Wash.

The relief of the county as a whole is moderately subdued, with the exception of a conspicuous rough broken mountainous area including approximately 20 square miles a few miles west of Bremerton. This area ranges in elevation from 1,000 to 2,500 feet above sea level and consists of a series of high narrow elongated gently rounded ridges with steep dissected slopes separated from one another by moderately narrow undulating lowland belts. The only other elevated land is that in the central part of the county. It extends in a general north-south direction, and most of it ranges from 200 to 300 feet above sea level. A few hills or ridges reach a height between 400 and 500 feet. East and west from this higher land, there is a

gradual slope almost to the coast. Bordering the shore, a discontinuous narrow strip of steep broken land, which in most places ranges from 100 to 400 feet in width, alternates with a few narrow strips of lowland that slope downward by relatively easy stages to the water line. This steep broken terrain extends inland for short distances along some draws or drainageways, issuing from the uplands. In many places, nearly vertical bluffs along the shore rise to a height ranging from 50 to 150 feet.

The rest of the land comprises undulating and gently rolling uplands and smooth flat or slightly depressed areas, wherein differences in elevation in few places exceed 200 feet. Radiating south from Port Orchard are a number of plainlike areas. Their occurrence, outline, and extent are extremely variable, and, in places, they form a series of terraces or smooth ridges, one above another, separated by abrupt steplike breaks or slopes. Similar areas are scattered throughout the central part.

Perennial streams are few in proportion to the area of the county. A striking feature of the drainage system is the absence of comparably developed lateral or tributary streams. The main streams are fed for the most part by a few short intermittent tributary streams or springs flowing down the slopes in draws or incised narrow steep-sided ravines. Ridges between the main stream valleys are broad, smooth, and free from the deep and intricate dissection developed by a dendritic drainage system. The surface of the ridges is irregular and undulating, owing to the accumulation of glacial ice-laid materials. The characteristics of the main valleys and the absence of a well-established network of streams tributary to the main valleys are probably the effects of glacial agencies. The interstream ridges are separated by several northeast-southwest valleys, each occupied by a small stream flowing southward. The depth, slope, meanders, and irregular width of the valleys, which do not conform to the streams, constitute further evidence that the valleys antedate the streams occupying them.

The greater part of the land is sufficiently and naturally well drained, either as a result of surface run-off or by rapid subdrainage through pervious substrata, for agricultural use. Only a small proportion—probably less than 10 percent—is naturally excessively wet or poorly drained on account of sluggish run-off, a high water table, or impervious substrata. The poorly drained land is comprised of small widely distributed areas of either mineral or organic soils in valleys or depressions of the undulating uplands or in swales and flats within the smooth ridges or plainlike areas.

The virgin timber growth consisted dominantly of Douglas fir, interspersed with western hemlock, spruce, western red cedar, willow, alder, Oregon maple, vine maple, and madrona. Practically all the original timber has been removed by lumbering or by fire. Conifers and deciduous trees reseed in most of the cut-over or fire-scarred areas and rapidly attain a promising growth for future utilization. Reforestation of the land, therefore, is not yet a serious problem except in places where successive burnings have destroyed the seed supply. The undergrowth is a luxuriant and dense tangle of many different plants, some of which grow to heights ranging from 4 to 6 feet. It consists mainly of salal, ferns, huckleberry bushes, Oregon grape,

rhododendron, vines, and coarse grasses. Fireweed is common over cleared and burned-over areas. Many of the marshy areas are treeless, and the principal growth in such places includes mosses, cranberry bushes, wire grass, reeds, rushes, sedges, ferns, and other water-loving plants. Conifers dominate the forests on the deep sandy soils of the Everett and Indianola series, and deciduous trees are common on soils with a higher water-holding capacity, such as those of the Kitsap and Alderwood series. In the wetter sections, alder is abundant among the evergreens, and in some such areas second-growth alder is the dominant tree.

The first white man to visit Kitsap Peninsula (in 1792) was the English explorer, Capt. George Vancouver. Settlement of the territory was not made, however, until about one-half century later. Until about 1850, when pioneers began to take up homesteads, the only white persons were transients, and Indians were the only residents.

Kitsap County was created from a part of King County in 1857. At that time it was called Slaughter County, but the name was later changed to Kitsap County. The earliest settlements were made along the coast, and the interior uplands were only sparsely settled. A number of small settlements and villages were established and plotted throughout the county between 1850 and 1870. The early settlers, who were mainly of Scandinavian, German, and English descent, came from Eastern and Middle Western States. Following the World War, the population was augmented to some extent by immigrants from northern Europe. At present, the farming population consists mainly of descendants of the early settlers and people who have recently established themselves in the rural sections. On Bainbridge Island, the rural population includes a small settlement of Japanese.

Since the organization of the county the population has increased at a moderate rate. According to the Federal census, it was 540 in 1860. In 1930 the population numbered 30,776, of which 20,606 were classed as rural and 10,170 as urban. Bremerton is the only city. It covers an area of a little more than 5 square miles. It is frequently called the "home of the Pacific Fleet," as the Federal Government maintains a navy yard there, where ships of the United States Navy are repaired and overhauled. The city is modern, with a number of schools, churches, paved streets, and sanitary facilities. The navy yard is the main establishment, and a large civilian force is employed there.

The small towns and rural settlements are situated principally along the coast or near the heads of some of the bays of Puget Sound. The more important are Port Orchard, the county seat, with 1,145 inhabitants, Poulsbo witlf 584 inhabitants, Tracyton, Kingston, Keyport (where a Federal torpedo station is maintained), Silverdale, and Manchester. Summer resorts, cottages, and camps, owned by residents of Seattle and other cities, line the shore. Bainbridge Island, particularly, is a favorite spot of many vacationists. The population of this island and the mainland is augmented by several thousand people each summer, who purchase a large proportion of the vegetables, berries, poultry, and dairy products produced. This county is also the home of many fishermen who go to Alaska and other places during fishing seasons. Small gardens are kept by the fishermen to

furnish part of their necessary sustenance while they are at home, and the surplus products are sold locally.

Although there are no railroads, frequent and adequate freight, automobile, and passenger transportation are furnished the towns and larger settlements along the coast by ferry to Seattle and other important points. A number of paved and improved highways traverse the county and connect all the important settlements and towns. The rural sections are well equipped with modern conveniences, and most of the farm homes are up to date. Consolidated schools are located at central points, and the pupils are transported to and from school by bus. Telephone lines extend to all villages and settlements, and many of the farmhouses are connected with such lines.

CLIMATE

The climate is temperate and oceanic in character. The influences of Puget Sound and the Pacific Ocean so modify both summer and winter temperatures as to eliminate periods of extreme heat or cold. The Olympic Mountains to the west form a barrier against cyclonic storms. These natural conditions create a pleasant equable climate throughout the year. The warm moisture-laden winds from the Pacific Ocean moving eastward under the prevailing influences of western winds and storm centers and cooled by their ascent of the western slopes of the Olympics release a heavy rainfall. Some winds entering through the Chehalis River Gap some distance south of this county also carry moisture into Puget Sound Basin and deposit it in gradually decreasing amounts as they move eastward toward the Cascade Mountains.

Several variable moisture belts extend across the county in a general north-south direction. The eastern part has an annual precipitation ranging from 30 to 40 inches. There is a gradual increase westward to as much as 60 or more inches. Although the total annual rainfall, if it were evenly distributed, would be sufficient for most agricultural operations, the summers are commonly dry, with inadequate rainfall for normal growth of many crop plants. The average rainfall for the summer, as recorded at the United States Weather Bureau station at Bremerton, is about 2½ inches. Consequently, many crops suffer for moisture during important periods of their growth, particularly in dry years. Pastures frequently become dry. In years when the summer rainfall is unusually heavy, harvesting is sometimes delayed. It is not uncommon for the wells to become dry on farms on the higher elevations. Farms on the higher ridges and located on soils such as the Everett and Indianola, are more likely to lack an adequate supply of water during summer than farms on similar soils developed on lower ridge slopes and in valleys. A shortage of water for crops during the summer may occur at any place in the county.

Table 1, compiled from records of the United States Weather Bureau station at Bremerton, gives the more important climatic data which are considered fairly representative for this county.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Bremerton, Kitsap County, Wash.*

[Elevation, 40 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1911)	Total amount for the wettest year (1902)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	42.0	63	26	6.28	3.33	14.17	0.8
January	40.3	59	14	6.03	5.08	5.31	6.4
February	41.2	63	18	4.71	2.48	12.35	4.8
Winter	41.2	63	14	17.02	10.89	31.83	12.0
March	45.8	76	21	3.33	1.06	5.25	1.9
April	48.8	86	29	2.27	1.11	2.95	.8
May	53.9	87	29	1.62	2.78	1.59	(1)
Spring	49.5	87	21	7.22	4.95	9.79	2.7
June	58.4	98	37	1.24	.54	1.03	.0
July	62.6	94	39	.58	.14	1.04	.0
August	62.5	95	41	.71	.07	3.07	.0
Summer	61.2	98	37	2.53	.75	5.14	.0
September	58.7	88	34	1.61	2.08	2.05	.0
October	53.0	85	30	3.13	1.20	2.25	(1)
November	45.6	74	16	6.53	4.19	6.26	1.7
Fall	52.4	88	16	11.27	7.47	10.56	1.7
Year	51.1	98	14	38.04	24.06	57.32	16.4

[1] Trace.

The comparative uniformity of temperature prevailing throughout the year is evident from the climatic table. The lack of large differences in mean temperature from one season to another is due in large measure to winds from the Pacific Ocean which are warmer in winter and cooler in summer than those from adjacent land areas. In summer, the days are seldom hot, and the nights are invariably cool. Some damage to crops results occasionally from cold and frosts, owing to unfavorable location with respect to air drainage. Some areas having good air drainage, along and adjacent to the upper slopes of some of the valleys, are entirely free from frost and low temperatures, that occur at the same time on the lower valley floors which are subject to accumulation of cold air from the upper valley slopes.

The average frost-free season, from April 3 to November 5, inclusive, extends over a period of 216 days. The latest killing frost recorded at Bremerton is April 28, and the earliest is September 25. Farmers are fairly well assured of a sufficiently long growing season, in most years, to mature crops.

The proportionate number of clear and cloudy days is an important feature of the climate. The Weather Bureau station at Bremerton recorded only 130 clear days in 1936. The rest were cloudy or partly cloudy. The relatively high humidity results in the formation of heavy fogs and dew when the temperature is slightly

lowered. Consequently, during a large part of the year, the sun is hidden from view by rain, fog, and clouds. These elements have influence on the growing, maturing, and harvesting of crops.

The total annual snowfall is light, and the snow soon melts after reaching the ground. The prevailing winds are from the south and southwest. During winter, high winds attain velocities ranging from 25 to 45 miles an hour, but they are seldom destructive. During summer the average velocity of winds is lower, and the number of windy days is less than in winter.

AGRICULTURE

When the first settlers arrived in Kitsap County, there were vast forests of fine stately evergreens. Clearings were few, except those made for Indian villages along the coast. In the early days, lumber companies established sawmills and started operations along the coast and in valleys which were more easily accessible than the interior uplands. Small settlements and villages gradually sprang up about the sawmills, and some crops were grown for local consumption and to meet the demands for farm products. Cultivation was restricted to small areas in valleys and on the valley slopes, which had been logged and cleared of stumps.

Little or no development took place in the interior. Clearing the land of trees, stumps, and underbrush was expensive and required much time and physical effort. In the early days, difficulty of accessibility, unfavorable topography, inadequate water supply, cost of clearing, and the adverse character of some of the soils discouraged agricultural utilization of the interior uplands. Even to the present there has been little development, except in small areas adjacent to the coast towns and settlements. Farms in the central part of the county are few and widely scattered. Some have been abandoned or are operated on a part-time basis. Some clearing of land is still in progress on small tracts as the time of the farmer allows. It sometimes requires several years to prepare a patch for cultivation.

Wheat, oats, potatoes, hay, and vegetables were the major crops in the early days. Some poultry and dairy cattle were kept to supply home requirements, and the surplus products were marketed locally.

According to the 1935 Federal census, farms occupy only 38,523 acres, or 16.2 percent of the land area of the county, of which 12,230 acres are available for crops (including 3,050 acres in plowable pasture), 8,370 acres in woodland pasture, 3,876 acres in other pasture, 9,974 acres in woodland not pastured, and 4,073 acres in all other land.

Cereals, chiefly wheat and oats, are produced on only a small acreage and are largely consumed on the farm where grown. Corn was grown for silage, forage, and fodder on 61 acres in 1934. Practically none is grown for grain. The larger part of the cleared land is devoted to hay which is fed to dairy cattle. The most important hay crops are timothy and clover (alone or mixed), small grains, legumes, and native grasses. Clover does moderately well on both bottom and upland soils and is an important part of the hay crop. Alfalfa has been successfully established by some farmers, but it is generally confined to small patches of less than an acre each. Pastures are maintained chiefly on bottom lands where mois-

ture conditions are most favorable in summer for the growing of grasses. The stump land adjacent to cleared fields sometimes is used for grazing. The herbage in pasture consists mainly of native grasses and legumes and also includes a variety of coarse unpalatable grasses, weeds, and some reeds and sedges.

Potatoes are grown only in small selected patches and not on a commercial scale. Truck gardening was conducted on 304 acres in 1929. The land devoted to vegetables included 292 acres in 1934, and the value of vegetables sold amounted to $58,868. Vegetables of many kinds are grown, including tomatoes, peas, sweet corn, lettuce, cabbage, string beans, and onions. Most of the surplus crops are marketed either in Bremerton or nearby villages or are sold direct to summer residents. Commercial production of vegetables on an intensive scale is conducted by a few farmers, but such operations are limited to small acreages.

The growing of small fruits, particularly strawberries, has been developed intensively in some sections, principally in the central part of Bainbridge Island. In 1934, strawberries were grown on 564 acres and produced 1,238,339 quarts. Several canning factories on the island handle most of the crop and process it for future consumption, but some of the fresh fruit is marketed in Seattle. Blackberries, Logan blackberries, and raspberries are grown in a small way.

Orchards, vineyards, and land planted to nut trees occupied 591 acres in 1934. The important tree fruits are apples, pears, cherries, plums, and prunes. The land actually devoted to fruit on each farm is only a minor part of the whole and on very few exceeds 5 acres. There have been very few new plantings in recent years, therefore most of the trees are of bearing age. Many plantings are confined to small groves of about 5 to 30 or more trees, and few orchards in connection with general farming cover more than 1 acre. Scant attention to spraying, pruning, or fertilizing is observed in many orchards. Frequently the ripened fruit is allowed to fall to the ground and rot. Generally, the better grades are sold locally, but the fruit carried to market is only a small percentage of the yield obtained. Fruit is an important source of income, however, on a number of farms, and its total value for the county exceeds that of vegetables. Fruit free from disease and insect injury is generally of good quality and flavor.

Table 2 shows the trend of crop production from 1899 to 1934, inclusive.

TABLE 2.—*Acreage of principal crops in Kitsap County, Wash., in stated years*

Crop	1899	1909	1919	1929	1934
	Acres	*Acres*	*Acres*	*Acres*	*Acres*
Wheat	4	8	86	106	21
Oats	10	4	73	71	92
Barley	-------	-------	9	8	6
Dry peas	-------	1	4	2	44
All hay	2,471	3,644	6,472	5,050	[1] 6,199
Timothy and/or clover	377	2,163	2,225	1,437	1,731
Grains cut for hay	31	1,189	2,167	1,777	[1] 1,889
Alfalfa	-------	1	29	53	34
Other tame hay	2,053	169	1,862	1,352	44
Wild hay	10	122	189	431	[2] 2,501
Potatoes	248	418	594	349	216
Vegetables for sale	89	260	120	304	292

[1] Includes sorghums for silage and fodder.
[2] Includes tame and wild grasses.

TABLE 2.—*Acreage of principal crops in Kitsap County, Wash., in stated years*—Continued

Crop	1899	1909	1919	1929	1934
	Acres	*Acres*	*Acres*	*Acres*	*Acres*
Strawberries	10	68	271	369	564
Raspberries and Logan blackberries	4	21	41	47	[3]
Blackberries	1	11	23	5	[3]
	Trees	*Trees*	*Trees*	*Trees*	*Trees*
Apples	21,911	40,705	45,876	22,694	18,582
Pears	1,317	3,479	4,121	3,320	2,978
Plums and prunes	6,618	7,913	5,914	4,273	3,629
Cherries	1,179	3,413	8,441	5,028	6,140
	Vines	*Vines*	*Vines*	*Vines*	*Vines*
Grapes	-------	73	209	15,045	13,890

[3] Not reported.

Dairy products form a major source of agricultural income. During the earlier years dairy cattle were of low grade, but such herds are being replaced by high-producing, purebred animals of recognized breeds. The number of cattle, according to the 1930 Federal census, was 4,716, valued at $308,685. The number increased to 5,213 in 1935. The census reports show that moderately good incomes are received by the majority of farmers in the dairy business. Milk produced in 1929 totaled 1,935,905 gallons, and 892,172 gallons of whole milk, 42,375 pounds of butter, and 120,896 pounds of cream were sold for a total of $266,905. The production of milk increased slightly to 2,038,748 gallons in 1934. Many of the farmers on farms where dairying is practiced as a side line keep 2 or 3 cows, but on regular dairy farms many of the herds range from 6 to 15 or more milk cows. Milk is collected by milk trucks following definite routes and then taken to receiving stations or creameries.

The raising of sheep, swine, or beef cattle forms a subordinate type of animal husbandry. Sheep raising may be considered as incidental, for there were only 444 head in the county in 1935. The annual income from wool is insignificant. Very little land has been devoted to the growing of corn and other cereals necessary for producing pork of high quality, and the commercial production of swine in this county is of minor importance. The number of hogs raised fluctuates from year to year. The number reported in 1935 was 1,242. The hogs are kept principally for a home supply of meat.

Only 646 horses and 10 mules are reported on the farms in 1935. On many small ranches most of the farm work is done by hand. Horse power is required for the dairy and general farms.

Among the farm products, poultry products rank first in importance, and the income derived from them is much larger than the combined income from all other products sold. Kitsap is one of a group of counties adjacent to the Puget Sound Basin that has entered the commercial poultry enterprise on a large scale. Climatic conditions are favorable for intensive poultry production, and rapid growth has resulted in the last decade and a half. A number of cooperative organizations for the marketing of eggs and the purchasing of feeds have been established and are carried out on a successful basis. The value of the 460,076 chickens raised in 1929 was $437,072, of which 247,838 were sold alive or dressed. The value of

the 3,746,978 dozen eggs produced was $1,199,033. In 1934, 2,126,781 dozen eggs were produced, and the number of chickens raised was 246,868. On the greater number of poultry farms chickens are raised solely for egg production. Some farmers specialize in raising turkeys for market, and a number of large commercial turkey-raising enterprises are conducted successfully in several parts of the county. Although the poultry farms range from as small as 3 acres to 300 or more acres, with the majority averaging about 50 acres or less, only a few acres are cleared for the poultry houses and runways. Some feed is grown, but most of it is purchased.

The total value of crops and livestock products produced in 1929 is given in table 3.

TABLE 3.—*Value of crops and livestock products in 1929, in Kitsap County, Wash.*

Crop	Value	Livestock products	Value
Cereals	$5,988	Dairy products sold	$266,905
Other grains and seeds	802	Wool shorn	451
Hay and forage	139,142	Poultry and eggs produced	1,657,835
Vegetables and potatoes	163,883		
Fruits and nuts	183,111	Total	1,925,191
Other field crops	1,392		
Nursery and greenhouse products sold	53,956	Total agricultural products	2,549,081
Forest products cut on farms for home use and sale	75,616		
Total	623,890		

The use of commercial fertilizers is limited to small areas, and applications of a complete fertilizer or materials supplying separate elements of nitrogen, phosphorus, and potash depend on individual preference. Some farmers apply a phosphate or nitrate fertilizer in small quantities. Only 227 farms reported the use of fertilizers in 1929, at an expenditure of $18,731, or an average of $82.51 a farm. The most extensive use of commercial fertilizer is on land devoted to truck and small-fruit crops. Heavy applications are made on land for strawberries on Bainbridge Island, and moderate applications are made for truck crops and orchard trees. All the available barnyard and poultry manure is used. Many farmers depend on plowing under grass or legumes for a supply of organic matter. Others still rely largely on the natural fertility of the land, supplemented by moderate quantities of animal manure to maintain soil productivity. The rapid depletion of virgin fertility under cultivation, especially on light-textured soils, unless organic matter is returned to the soil, is common knowledge.

No system of rotation is generally practiced. The character of the soils, the location of the farm in reference to local markets, the farm equipment, the type of farm, and many other factors determine the cropping system to be used.

The demand for labor is very irregular, but it is greatest during the plowing and harvesting seasons. On most farms, owners perform a large share or all of the labor. Farming systems requiring the supervision and labor of the farmer at all seasons are not yet developed on many farms, and some farmers spend a part of their time at other employment, such as lumbering. When additional

labor is necessary, it is generally obtained through exchange with neighbors. In 1929, 678 farms hired labor, for which $129,153 was expended, at an average cost of $190.49 a farm. Opportunities for employment in lumbering, in the navy yard at Bremerton, and in large cities cause farm labor to be rather scarce.

The trend for the last several census periods is toward an increase in the number of farms and a decrease in their size. In 1935, land in farms represented about one-sixth of the area of the county and was divided among 1,665 farms. The smallest included less than 3 acres, only 7 exceeded 174 acres, and no farm was larger than 379 acres. Therefore, many of the farms might be classed as subsistence homesteads where cultivation is carried on on a part-time basis. The average size of farms in the same year was 23.1 acres, of which 7.3 acres represented improved land including cropland and plowable pasture. The rest of the farm was largely woodland which ordinarily consists of a heavy growth of conifers, together with some mixed hardwoods.

Most of the farms are operated by their owners. The proportion of tenancy is small and has shown a slight decrease in recent years. The 1935 census reported 9.2 percent of the farms operated by tenants. The customary lease of farm land is on a cash basis rather than on shares. The rent per acre is not uniform, and rates differ in different sections. On Bainbridge Island, in the strawberry area, many farms are rented for prices ranging from $15 to $25 an acre. In other parts of the county, the range in rental is from about $3 to $10 an acre, depending on the location, type of farming, and general condition of the farm.

On most farms, the plowing is done with walking plows drawn by two-horse teams. The few tractors used are on some of the larger ranches. The farm machinery is generally sufficient to meet the somewhat limited requirements of small-scale cultivation. Automobiles are owned by most farmers. Motortrucks form a part of the farm equipment of many full-time farmers. They are used for hauling both farm and timber products. Barns differ widely in construction and size. They are built to meet the requirements of the individual farmer and generally are adequate for his particular purpose. Farmsteads on most farms are well-kept, painted, attractive buildings equipped with electricity and sanitary necessities. Dwellings on part-time and isolated farms are small or inexpensive cabins, many of which lack modern conveniences.

The present system of agriculture is based on poultry raising, dairying, and the growing of small fruits, and it has developed, for the most part, because of favorable economic factors and the geographic location of the farms in respect to markets, and such local natural conditions as climate and relief. The seasonal distribution of rainfall has had an important influence on the crops to be grown. The low rainfall during the growing season, when crops require ample moisture for normal growth, has restricted the growing of corn and other general farm crops.

Only in a general way do farmers, as a whole, recognize the crop adaptations of the different soils. Extreme conditions of drainage and texture apparently are the outstanding soil characteristics commonly considered in the growing of special crops, such as vegetables

and small fruits. Soil utilization in this county is not far removed from the stage of land exploitation. The opening of land for farming purposes at first was slow, owing to the cost and difficulty of clearing off the trees and stumps. The sites cleared were not chosen particularly for their adaptation to specific crops. The recent trend of urban workers in moving to the country and obtaining a part of their living from the soil has influenced the opening of new settlements and the clearing of small tracts of land for gardens. For a time following the World War, land development received an impetus by veterans and others who took up small farms, and many of these people still conduct their operations on a small scale.

The dominant use of land in selected representative parts of the county at the time this survey was made is shown on the accompanying sketch maps (figs. 2, 3, and 4).

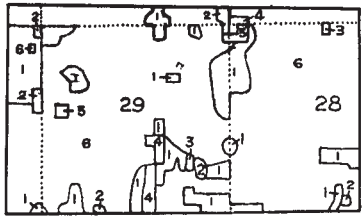

FIGURE 2.—Sketch map showing land use in sec. 29 and parts of secs. 28, 21, 20, 19, and 30, T. 24 N., R. 2 E.: 1, Pasture; 2, orchards and groves; 3, vegetables and small fruits; 4, hay; 5, wheat and oats; and 6, young timber.

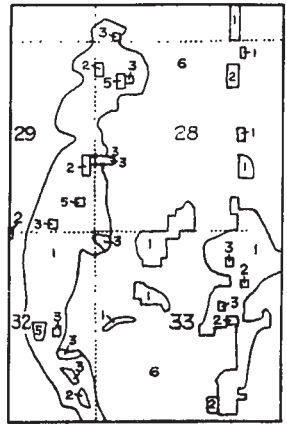

FIGURE 3.—Sketch map showing land use in secs. 28 and 33 and parts of secs. 21, 20, 29, and 32, T. 23 N., R. 2 E.: 1, Pasture; 2, orchards and groves; 3, vegetables and small fruits; 5, wheat and oats; and 6, young timber.

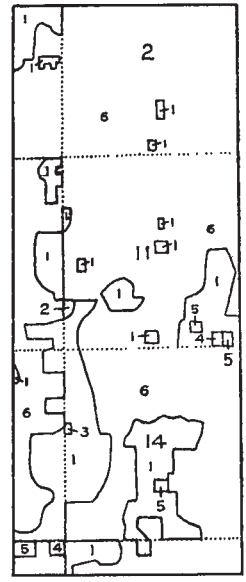

FIGURE 4.—Sketch map showing land use in secs. 11 and 14 and parts of secs. 2, 3, 10, 15, 22, and 23, T. 25 N., R. 1 E.: 1, Pasture; 2, orchards and groves; 3, vegetables and small fruits; 4, hay; 5, wheat and oats; and 6, young timber.

These maps indicate that the principal use of the land is for the growing of timber and that the timbered areas are larger than the combined areas of cleared and cultivated land. The acreage of farm

land in pasture is larger than that devoted to crops. Pastures include cleared land with natural herbage, stump land from which the undergrowth has been removed, and land seeded to grasses and legumes for grazing. The wet and more poorly drained areas are maintained for permanent grazing land. Part of the areas cleared and classed as pasture represents abandoned or idle land and is gradually reverting to second-growth forest.

Farm land utilized for purposes other than for pasture or timber growing is distributed in small tracts for the growing of cereals, vegetables, and fruits, and the raising of poultry. The smallness of these tracts is in striking contrast to the size of the hay and pasture fields. The small cultivated areas are scattered over a variety of soil types, and their location is likely to be due more to a matter of convenience than to particular adaptation of the crop to definite soil conditions.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers or horizons called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil[1] and its content of lime carbonate and salts are determined by simple tests. The drainage, both internal and external, and other external features, such as the relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, especial emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics, soils are grouped into classification units. The three principal ones are (1) series, (2) type, and (3) phase. Areas of land, such as coastal beach or rough mountainous land, that have no true soil are called (4) miscellaneous land types.

The most important of these groups is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first found. Alderwood, Edmonds, Indianola, and Kitsap are names of important soil series in this county.

[1] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the "pH value." A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Alderwood loam and Alderwood fine sandy loam are soil types within the Alderwood series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character is generally the soil unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type which differs from the type in some minor soil characteristic that may, nevertheless, have practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. For example, within the normal range of relief for a soil type, there may be areas which are adapted to the use of machinery and the growth of cultivated crops and others that are not. Even though there may be no important differences in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such an instance the more sloping parts of the soil type may be segregated on the map as a sloping or hilly phase. Similarly, soils having differences in stoniness may be mapped as phases even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS

The soils throughout Kitsap Peninsula have developed almost entirely from unconsolidated materials that were deposited over the local rock formations during glacial periods. Huge sheets of ice, in passing over the region, gathered and accumulated soil and rocks common to this section of the country and redeposited them as a mantle of miscellaneous materials. The depth of this mantle of glacial debris over the underlying consolidated formations ranges from 1 to 150 or more feet. The material left by the ice was mainly coarse grained and composed largely of a heterogeneous mixture of silts, sands, and gravel interspersed with small quantities of clay. Since deposition, weathering and biological agencies under the environment of a humid temperate climate have exerted their influence on these materials to develop the soils as they now exist.

The acquired characteristics and the more or less dominant mineral and structural characteristics inherited from parent geological materials are the bases of grouping the soils and soil materials of the county, as follows: (1) Soils with cemented hardpan or bedrock substrata, (2) soils with permeable subsoils and substrata, (3) organic soils, and (4) miscellaneous land types.

The outstanding feature of the first of the two most extensive and important of these four groups of soils is the development of a very

compact or firmly cemented and comparatively impervious hardpan layer in the lower part of the soil profile or in the underlying substratum of parent geological materials. This hardpan is sufficiently firm to prevent penetration by plant roots. Plants which have a large rooting system and send their roots downward from 25 to 30 inches, unable to enter the indurated layer, form a tangled mat on top of it. Such plants are restricted in their rooting habits. Downward percolation of soil moisture may be retarded by the comparatively impervious layer. This suggests that a temporary or perched water table may exist in places and, as a result, surface moisture conditions, during summers of low rainfall, may be at times more favorable in areas of soils having a hardpan than elsewhere. Large bodies of these soils are common throughout the northern and central parts of the county.

The distinctive characteristic of the soils of the second group, in direct contrast to that of the soils of the first group, is the openness and permeability of the subsoil and substratum, although the group includes some soils which have compact but uncemented subsoil materials. The soils of the second group are intricately associated in long narrow discontinuous belts adjacent to or along the valleys. In the southern part of the county a broad belt extends from Puget Sound westward to Mason County, and within this belt are small bodies of soils having a hardpan. In general, those soils in which there is some stratification of the parent soil material in the substratum are more or less friable, and most of the soils in which the original or parent material is composed of a heterogeneous mass of sand, silt, clay, and gravel have some formation of a hardpan.

The other two groups—the organic soils and the miscellaneous land types—are of small extent and minor importance.

In the following pages the soils and land types are described in detail, and their agricultural utilization is discussed; their distribution is shown on the accompanying soil map; and their acreage and proportionate extent are given in table 4.

TABLE 4.—*Acreage and proportionate extent of the soils mapped in Kitsap County, Wash.*

Soil type	Acres	Percent	Soil type	Acres	Percent
Alderwood loam	45,760	18.2	Indianola loamy sand, steep phase	3,584	1.4
Alderwood loam, steep phase	1,088	.4	Indianola fine sandy loam	1,344	.5
Alderwood fine sandy loam	32,128	12.7	Kitsap silt loam	6,656	2.6
Alderwood loamy sand	15,360	6.1	Kitsap silt loam, steep phase	3,136	1.2
Alderwood loamy sand, steep phase	1,600	.6	Kitsap silt loam, imperfectly drained phase	512	.2
Sinclair loam	2,560	1.0	Alluvial soils, undifferentiated	8,448	3.4
Edmonds loamy sand	2,176	.9	Greenwood peat	704	.3
Edmonds fine sandy loam	1,728	.7	Rifle peat	1,792	.7
Melbourne loam	320	.1	Spalding peat	896	.4
Melbourne loam, shallow phase	896	.4	Muck	1,280	.5
Melbourne loam, terrace phase	320	.1	Rough mountainous land	9,984	4.0
Everett gravelly sandy loam	46,400	18.4	Steep broken land	5,632	2.2
Everett gravelly sandy loam, flat phase	3,328	1.3	Coastal beach	384	.2
Everett gravelly loamy sand	17,600	7.0	Coastal beach, terrace phase	512	.2
Everett gravelly loamy sand, steep phase	11,136	4.4	Tidal marsh	192	.1
Indianola loamy sand	24,704	9.8	Total	252,160	------

SOILS WITH CEMENTED HARDPAN OR BEDROCK SUBSTRATA

Soils having a hardpan are those of the Alderwood, Sinclair, and Edmonds series, and those formed over consolidated bedrock are of the Melbourne series. The Edmonds soils occur on fairly smooth benchlands; the others have an undulating or gently rolling relief. Natural surface drainage ranges from fair to good, but in most places internal drainage is accomplished laterally over the top of the cemented layer. The surface soils are friable, mellow, and easily cultivated. The organic-matter content is low, but it is perhaps higher than in most other mineral soils in the county. The soils range from acid to moderately acid. When deeply plowed, these soils tend to absorb a large amount of rainfall. The effects of turning under a green-manure crop or applying barnyard manure are retained in the surface soil, as rapid percolation and deep leaching are prevented by the impervious lower lying material. The surface soils warm rather quickly in the spring, owing to their average well-drained porous character. A large part of the agricultural crops are grown on these soils wherever the relief is favorable. The soils are only moderately productive, however, and their utilization is limited to small scattered tracts.

The Melbourne soils, developed on consolidated bedrock, are shallow and of small extent.

Alderwood loam.—In undisturbed timbered areas Alderwood loam is covered with a thin organic layer of forest litter consisting of leaves, twigs, and stems, accumulated from the tree and undergrowth vegetation growing on the soil. The material in the lower part of the layer has undergone some decay and, where it rests on the soil, is mixed with mineral matter. This grades into grayish-brown or dark-brown gritty loam, which contains some small rounded iron-cemented pellets, locally termed "shot" (*7*),[2] and it is brighter or richer brown in the lower part. At a depth of about 12 inches, the material is pale brownish yellow or yellowish brown, and the shot are fewer, smaller, and softer than those in the upper layers. The color also becomes lighter with depth, and grades at a depth of about 24 inches, into light gray mottled with yellow and lighter gray. This is an irregular transitional zone from the overlying layer to the hardpan, on which it rests, abruptly, at a depth of about 30 inches. The hardpan layer is light-gray or ash-gray firmly cemented loam in which there are thin horizontal laminations. The material in this layer resists fracture but will crumble to a powdery mass when broken. The cementing material appears to be mainly silica. Plant roots cannot penetrate this layer but are matted on top of it and throughout the overlying material. Below a depth of about 40 inches is light-gray or dull-gray firmly compacted or slightly indurated gritty loam. Some road cuts or exposures show that this material extends to a depth exceeding 25 feet.

Stony fragments ranging from small pebbles to moderate-sized boulders, many of which range from 1 to 2 feet in diameter, are present in various quantities in each layer. The quantity varies also from one location to another, but, in most places, it is not large enough to interfere with farming operations. The fragments are principally granite, basalt, sandstone, and shale derived from local and foreign rock

[2] Italic numbers in parentheses refer to Literature Cited, p. 41.

formations. The accumulation of rounded pellets of iron-cemented material, or shot, in the upper part of the soil is a characteristic feature of Alderwood loam. These pellets are also scattered over the surface of the soil. They occur in sufficient quantity to affect the physical nature of the soil material and impart a porous friable consistence. In cultivated fields, the mixing of the organic and mineral layers produces a brownish appearance in the surface soil. As the soil dries, it becomes lighter brownish gray or gray.

The relief, for the most part, is undulating or gently sloping. The soil, from the surface down to the hardpan layer, is well drained, and its structure allows ready percolation of soil moisture. Moisture does not penetrate the hardpan but accumulates on top of it, and most of the water flows away over the hard layer.

Alderwood loam is fairly uniform in its development, but some variations exist in color, depth of the several layers, and firmness of the hardpan. A few small areas are included in which the texture varies from that of the typical soil, but such differences cause little practical significance in land utilization. South of Seabeck, associated with Everett gravelly sandy loam, is an included area in which the soil is characterized by irregular narrow tongues of red, brown, or purple material extending downward through the subsurface and subsoil layers. The color is not uniformly developed, but it is darker than in typical Alderwood soils. The sandstone, shale, and granite gravel present are coated with red material developed in the weathering of the stone fragments. Some small spots of Everett and Sinclair soils are included with Alderwood loam, but these do not affect the general classification of the land as regards its value for farming.

A more extensive and important variation of soil is distinguished from typical Alderwood loam by its duller color, heavier textured subsoil, and more massive blocky structure. It is derived from local sandstone and shale and is influenced to a larger extent by these materials than is the typical soil. It occurs in ridged, strongly undulating, hummocky, and sloping areas, and with each type of relief are variations in color, drainage, and degree of compaction. The better drained areas tend to be more brown, more yellow, and free from gray stains, whereas the more poorly drained depressions or seeped spots have dark-gray topsoils and highly stained gray subsurface and subsoil layers. Changes in color, degree of mottling, thickness of layers, texture, and structure within short distances are characteristic of this included soil. Where weathered shales have contributed dominant parent materials the texture is heavier than in places where weathered sandstones predominated in the formation of the soil.

The largest typical developments of Alderwood loam are in the western part of the county and on Bainbridge Island. The other areas are small and scattered.

The forest on Alderwood loam consists dominantly of conifers. Douglas fir is the principal tree, and western hemlock, spruce, cedar, pine, alder, madrona, and western maple are included in the growth. Salal, Oregon grape, swordfern, rhododendron, huckleberry bushes, bracken, vines, brush, and grasses form a dense and almost impenetrable undergrowth.

The total acreage of cleared and cultivated land is small. Probably less than 1 percent is devoted to the growing of crops or used for

other agricultural purposes. The remainder is timbered or cut-over land which rapidly is becoming covered with a heavy second growth of trees and underbrush. Poultry raising and dairying are the major activities developed on this soil. The growing of holly for floral and ornamental purposes has become a specialty on a few acres. The largest tilled area is in the central part of Bainbridge Island. Here the land is cultivated intensively for the production of strawberries, largely by Japanese who have brought the farms under their management to a high state of productivity. Most of the strawberry crop grown in this section is processed by local canning factories.

Few farms have been developed on Alderwood loam in the more elevated interior, owing to the difficulty experienced in obtaining an adequate supply of water during dry seasons of the year. Some farms which have been established are now idle or abandoned. The low rainfall during summer creates some hazard for crops in all parts of the county. Most of the cleared farms on Alderwood loam are on or adjoin valley slopes where natural moisture conditions are more favorable.

Clover does moderately well and yields an average of about 1 ton an acre. Practically no corn is produced and very little wheat and oats. Yields of oats average about 30 bushels and wheat 15 bushels an acre during favorable seasons. Barley yields from 10 to 14 bushels, and potatoes about 100 bushels. Although yields are stated on an acreage basis, many farms have less than 1 acre devoted to each of these crops. Oats are grown principally for hay to be fed to livestock. In fact, most crops are utilized directly on the farm.

The high cost of clearing land in this county and the lack of moisture in summer are important factors limiting the utilization of Alderwood loam. Its natural crop-producing capacity has received little attention. The location of the soil in respect to markets for other than specialized types of farming should be studied carefully before more land is cleared and developed for cultivation.

Alderwood loam, steep phase.—The designation of Alderwood loam, steep phase, separates on the map those areas of Alderwood loam that are too steep for practical farming purposes. For the most part, these are small narrow belts between different levels of Alderwood loam, or they occupy slopes bordering valleys which have been cut by drainageways into deep narrow V-shaped ravines. Most of this steep land remains in timber. The few cleared areas are not cultivated but are used for pasture. The chief value of this soil is for the growing of timber, to which it is best suited under existing economic conditions.

Alderwood fine sandy loam.—Alderwood fine sandy loam is distinguished from Alderwood loam by its coarser texture, greater content of sandy material, and lower water-holding capacity. The color and arrangement of the several layers are similar to those features of other Alderwood soils. The soil is covered with a 2- or 3-inch mat of organic material. The dark-gray color of the topmost 1 or 2 inches of mineral soil is the result of an admixture of decayed forest litter. In places a thin veneer of light-gray loamy sand overlies the upper part of the soil. Between depths of about 2 and 9 inches,

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the material is brown fine sandy loam. Below this and extending to a depth ranging from 30 to 40 inches is lighter brown or yellow loamy fine sand or loamy sand, the lower part of which is slightly streaked with gray in places, particularly where it rests on the underlying hardpan. Rounded hard pellets of iron-cemented soil material, or shot, are moderately abundant in the uppermost 10 or 15 inches of the soil. The 6- to 12-inch light-gray hardpan layer is laminated. When dry, it has a cementlike hardness and is practically impenetrable to plant roots, but during the rainy season it becomes moist in some places from ground water and appears less firm. Underneath the hardpan is a mixture of very compact slightly cemented loam, fine sandy loam, and sandy loam materials. Stone and gravel are present in places, but the quantity is not sufficient to interfere with cultural operations.

Some variations in texture exist in a few small areas mapped as Alderwood fine sandy loam, within areas of the typical soil and in places where it adjoins bodies of other soils. There are also some inclusions of Indianola and Everett soils.

The surface configuration is that of an undulating plateau modified by flat, sloping, or rounded knolls. The porous nature of the upper sandy layers allows adequate and fairly rapid movement of soil moisture through them. Underdrainage, however, is impeded by the impervious character of the hardpan and substratum layers.

An intermittent belt of Alderwood fine sandy loam extends through the central part of the Kitsap Peninsula, north of Silverdale. Several narrow belts extend north of East Bremerton, and areas ranging up to about 3 square miles are scattered throughout the southern part of the county. Where it is associated with Alderwood loamy sand, Alderwood fine sandy loam generally occupies the smoother and upper parts of the ridges, whereas the loamy sand soil is along the adjoining slopes and drainageways.

Only a very small acreage of Alderwood fine sandy loam is cleared and used for the production of farm crops, although it probably exceeds slightly the tilled acreage of Alderwood loam. The chief crops grown on this soil are tame hay, oats, wheat, and clover, which are fed to dairy cattle. Some barley is produced, mostly in patches of less than 1 acre each. Although vegetables, small fruits, and tree fruits are grown on only small tracts of soils on individual farms, the total produce forms a large proportion of that grown in the county. Yields average about the same or slightly lower than those obtained on Alderwood loam. Seasonal factors of rainfall and the number of clear and cloudy days contribute to the success or failure of crops. Many of the farms are subsistence farmsteads which produce very little above the requirements for the farmer's family. Poultry raising and dairy farming are the chief sources of income on many farms. Surplus crops are sold on local markets.

This soil is easily worked and holds a good supply of moisture if properly cultivated. The crops on the few acres under cultivation indicate that the soil is fairly well adapted to nearly all the crops of the section, especially hay, fruits, and vegetables.

Alderwood loamy sand.—Under undisturbed forest conditions, 2 or 3 inches of forest litter covers the the 1- or 2-inch dark-gray or dark-brown loamy sand surface soil of Alderwood loamy sand. Below this is brown loamy sand to a depth of about 10 or 12 inches, where

it merges into yellow or light-yellow material of similar texture, which, in turn, becomes lighter colored and shows irregular gray stains with depth. Rounded hard accumulations of iron-cemented soil material, or shot, are present throughout the upper part of the soil. The light-gray hardpan characteristic of the Alderwood soils is reached at a depth ranging from 28 to 35 inches. Below the hardpan is a mixture of sand and silt, which forms a more or less compact firm mass, continues downward for many feet, and contains some small and large boulders.

Development of this soil is much more irregular, particularly in the northern part of the county, than that of other members of the Alderwood series. The sandy layers above the hardpan vary in depth, color, and degree of staining. The dominant texture is loamy sand, but inclusions are made of small areas of loamy fine sand or fine sandy loam. The hardpan is not uniformly firm, and, in some areas, only a thin compacted layer of loamy material, that does not resist root penetration, is developed.

Alderwood loamy sand occurs mainly in the northern part of the county, in small bodies ranging from ½ to 3 square miles, the largest of which are in the vicinities of Eglon, Port Gamble, and Island Lake.

The relief varies, ranging from fairly level in the upland flats or plateaus to hilly and broken. Surface drainage is thorough and, in the more uneven areas, tends to be excessive.

The forest growth consists chiefly of Douglas fir, hemlock, cedar, alder, spruce, and some madrona. The dense undergrowth is mainly salal and ferns.

Only a very small acreage is under cultivation. Most of the land has been logged, and many parts of it are being covered by a heavy second growth of trees. Crops grown on this soil are mainly those essential for dairying, such as grass, clover, and oats cut for hay. Potatoes are planted chiefly for home use, and small quantities of fruit and vegetables are sold in local markets. The yield of oats ranges from 25 to 40 bushels an acre; of potatoes, 75 to 125 bushels; and of clover, averages about 1 ton. Few of the general farm crops are produced in fields larger than 1 acre. Poultry raising is a major source of income on most of the cleared areas. Patchy farming operations are the general practice, and no definite system of rotation is maintained. The cost of clearing the land, together with excessive drainage and limited rainfall during summer, handicaps agricultural utilization of this soil. Few additional areas are being cleared for farming, although many farmers derive income from the sale of timber and other forest products.

Alderwood loamy sand, steep phase.—Narrow belts of the steep phase of Alderwood loamy sand are associated with other Alderwood soils along some of the small stream valleys. These areas are too steep and broken for the practical use of farming implements. When cleared they are subject to surface erosion, with an accompanying depletion of natural fertility. A few areas are traversed by short drainageways that have cut deep narrow V-shaped ravines, thereby rendering the land too steep, even for pasture. In such places the soil varies in color, texture, and structure.

A few tracts along the lower parts of slopes merging with the smoother land have been cleared and are used for pasture. The rest of the land is covered with forest from which some trees occasion-

ally are cut for firewood or posts. It is the opinion of most landowners that this steep soil offers little economic return if cleared and developed for farming operations.

Sinclair loam.—In undisturbed forested areas the thin surface layer of Sinclair loam is covered with a 2- to 3-inch layer of forest litter. The surface layer consists of mixed mineral soil and organic matter, about 2 inches thick, which is destroyed by cultivation. A large quantity of rounded pellets, or shot, is present. The material in this layer grades into lighter brownish gray or gray gritty loam which also contains a large quantity of shot. This material, in turn, grades, at a depth of about 10 inches, into light-gray or pale-yellow finer and silty loam containing fewer shot. The material in the lower part of this layer is stained with rusty brown. It rests, at a depth of about 30 inches, on a 10- or 12-inch light-gray cemented thinly laminated sandy substratum. Below this is light-gray compact sandy material in which gravel and cobblestones are embedded.

The presence of a large number of small iron-cemented pellets or shot in the upper part of the soil is a prominent feature of Sinclair loam. In places these constitute 50 percent or more of the soil mass. They are about the size of peas or buckshot, are rounded, and are darker colored on the outside than on the inside. In some places the soil has a light-gray mottled appearance which varies in intensity of color and degree of mottling and does not develop the brown coloration common to the Alderwood soils. The gray color is most noticeable when the soil is dry. As mapped, small areas of fine sandy loam and silt loam are included.

Sinclair loam occupies smooth level areas or very gentle slopes at the heads or sides of drainageways where ground-water movement is slow or retarded. The structure of the upper part of the soil allows adequate drainage just as the corresponding layers do in Alderwood soils. The impervious hardpan, however, practically stops downward percolation, and the smooth relief retards lateral drainage so that the soil remains wet for some time after heavy or prolonged rains.

The largest areas of Sinclair loam are southwest of Port Orchard and north of Poulsbo. A few smaller areas are widely scattered in other parts of the county. Some spots of associated soils, the limited size of which precludes separation on a map of the scale used, are included with Alderwood loam.

Only a very small acreage is under cultivation at present. The cleared areas are utilized principally for gardening or poultry raising, and a few are included in pasture. The rest of the soil is covered with conifers interspersed with alder, willow, and some maple. Some of the wood lots are a source of supply for firewood and fence posts. The present contribution of Sinclair loam to crop production and agricultural income in the county is very small.

Edmonds loamy sand.—In cultivated areas the surface soil of Edmonds loamy sand to a depth of about 6 inches, is yellowish-brown or light-brown loamy sand, through which are scattered a moderate number of shot. In undisturbed virgin areas this layer is covered with a thin layer of dull grayish-brown material with a higher content of organic matter and a loamy texture. The subsoil, which extends to a depth of about 28 or 30 inches, is yellowish-gray or grayish-yellow loose loamy sand containing seams and spots of

lighter gray. This grades into material of similar color and texture, which contains lumps and masses of sandy material streaked with yellow and brown and more or less cemented by iron and associated minerals and organic compounds deposited from solution. In some places, below a depth of about 34 inches, a firmly cemented hardpan is present. It is rusty brown, yellow, red, and gray, and about 6 inches thick. Underneath is light-gray sandy material mottled with iron stains. It is more permeable than the hardpan but is still compact or irregularly and softly cemented. Included in mapping are areas of Edmonds fine sandy loam, which are too small to show separately on a map of the scale used in this survey.

The relief is characterized by level, smoothly sloping, faintly undulating areas or knolls and intervening long narrow depressions. Natural drainage of the upper layers of soil is likely to be excessive, owing to the open structure of the sand. Underdrainage is fair but is restricted by the compact and more or less cemented subsoil layer. This layer aids, however, in increasing the moisture-holding capacity of the soil.

Edmonds loamy sand occurs only in small widely distributed bodies, most of which cover less than one-fourth square mile. A few are in the southeastern part of the county south of Point Glover and in the northern and north-central parts. Most of them are on narrow benches adjacent to or bordering drainageways or small streams.

Only a small proportion of the land is under cultivation, and it comprises but a small part of any one farm. Patches are sometimes farmed in conjunction with and in the same manner as adjoining soils. The production of potatoes, vegetables, hay, and pasture constitutes the principal utilization of the land. Some dairying is followed on farms including a combination of this and associated soils. The areas of Edmonds loamy sand afford fairly good pasture of native grasses and legumes on account of the moist character of this soil. No definite system of pasture management is maintained, and in places weeds and coarse unpalatable moisture-loving plants have encroached on the pasture fields. Crop yields are comparatively low unless the land is heavily fertilized and properly managed.

Edmonds fine sandy loam.—The 8- or 10-inch surface soil of Edmonds fine sandy loam is very dark gray or dark brownish-gray sandy loam, loam, or fine sandy loam, the last-named texture predominating. The dark color results from an accumulation of organic matter. The material in this layer is abruptly underlain by dull-yellow compact loamy fine sand or loamy sand, splotched with gray and containing small masses of rusty-brown iron-cemented material. This grades, at a depth of about 22 inches, into light-gray sand or fine sand, containing small lenses of dark sandy material. The lower part of the subsoil, in places, is cross-bedded with sand, fine gravel, very fine sand, and silty materials.

The texture and drainage of this soil are not uniform. In places the light-gray material directly underlies the dark topsoil. Thin interbedded layers of gray clay and silt loam, which are present in some places in the subsoil, are responsible for wet or springy spots and for a high water table. Near Silverdale a small area of Edmonds fine sandy loam containing a large amount of gravel is shown

on the soil map by gravel symbols. In some depressions the surface soil is composed largely of organic matter which causes it to be mucky.

Natural drainage is poor, and pronounced leaching of the layer below the surface soil has taken place. Natural fertility ranges from good to fair. Edmonds fine sandy loam is one of the least extensive soils mapped in this county. It occurs in small widely distributed areas which are devoted almost entirely to pasture and woodland.

Melbourne loam.—The 2- or 3-inch surface layer of Melbourne loam, as mapped in this county, consists of dark-gray, dark grayish-brown, or black loam, a large proportion of which is organic matter. It is underlain, to a depth of about 10 inches, by rich reddish-brown gritty friable loam containing small gravel and some shot about the size of peas. Underneath is light-brown or light grayish-brown loam or gritty silt loam, faintly stained with gray in places, which grades, at a depth of about 22 inches, into grayish-brown gritty gravelly light clay loam splotched with rust yellow and gray. This layer is about 4 inches thick and represents a transition to the underlying light reddish-brown or rich-brown cemented or consolidated gravelly material which continues downward to a depth of about 40 inches. Below this is a thick layer of lighter colored or grayish-brown material, similar in texture and structure, underlain by cemented massive gravel beds or conglomerate rock. Over the surface and throughout the several layers of the soil are some rounded glacial gravel and cobblestones, which are coated with dark rusty-brown stains and have a surface which is glossy when moist.

Natural drainage on the whole is good, but underdrainage is hindered by the underlying compact and more or less consolidated substratum. The relief is comparatively level or undulating.

The soil is represented by only two small bodies near Port Blakely on Bainbridge Island. With the exception of a few acres which are not cultivated at present, the land is covered by trees. Some of the partly cleared land is in pasture. With proper management in maintaining the supply of organic matter and moisture, this soil probably would prove suitable for the production of farm crops, vegetables, and fruits.

As recognized and mapped in this survey, Melbourne loam differs from typical Melbourne soils developed elsewhere, in the character of the deeper substratum and parent materials and in the darker color and higher content of organic matter in the surface soil. This soil is, however, most closely related to the Melbourne soils, and, because of its small extent and slight importance, it has not been given a different series designation.

Melbourne loam, shallow phase.—The immediate surface soil of Melbourne loam, shallow phase, is a thin layer of dark-brown or grayish-brown gritty loam, in most places less than 2 inches thick, beneath which is dull-yellow, grayish-yellow, or yellowish-brown gritty loam, silty loam, or silt loam, resting on bedrock at a depth ranging from 5 to 18 or more inches. The brown or red underlying rocks are interbedded, folded, and uplifted layers of sandy shale, sandstone, and conglomerates. A few stones and boulders of foreign rock, including granite and other crystalline rocks of glacial accumulation, are scattered over the surface. The parent soil material has been derived largely from weathered and underlying local rock for-

mations, each kind imparting some influence on the texture and structure of the soil material.

The relief includes smooth undulating areas, knolls, narrow rounded ridges, and a few steep slopes. Drainage, although almost entirely internal, is fairly good except in a few places.

This shallow Melbourne soil is inextensive. One small body is mapped at the southern end of Bainbridge Island, and several small bodies lie north of Manchester. Practically all of this land is still timbered. Some use of the underlying rock has been made for road building. The agricultural value and importance of this soil are low.

Melbourne loam, terrace phase.—The uppermost 1 or 2 inches of Melbourne loam, terrace phase, is a mixture of organic matter and dark-gray granular loam, underneath which is brown or light-brown loam or loamy fine sand. This material grades, at a depth of 6 or 7 inches, into grayish-yellow or light yellowish-brown loam or loamy fine sand, stained with gray, rusty brown, and rusty yellow. Bedrock of sandstone, shale, or conglomerate, from which the soil is developed largely, is abruptly reached at a depth of 14 or 15 inches below the surface. This soil, as mapped, is variable in texture and includes silty and sandy materials. Also included are patches in which the surface soil is very dark gray highly organic loam, about 4 or 6 inches thick. There is little change in color to the underlying rock.

This soil occupies narrow flat benches or terracelike positions ranging from 5 to 20 feet above tide level and from 100 to 200 feet in width along the coast in the southern part of Bainbridge Island and in the vicinity of Manchester. Its total extent is very small.

Some of this land is used for shore sites for resorts or summer homes, and a few acres are in pasture. On the whole, however, the land either is undeveloped or abandoned and is covered with a forest of fir, willow, and alder, and a tangled undergrowth of salal, moss, ferns, rose bushes, berry vines, and other plants.

SOILS WITH PERMEABLE SUBSOILS AND SUBSTRATA

The mineral soils characterized by loose, porous, permeable, and friable subsoils include members of the Everett, Indianola, and Kitsap series, and alluvial soils, undifferentiated. They are extensively developed, particularly in the southern part of the county, where elevations range from 50 to 400 feet above sea level. The relief is smooth or undulating, and these soils topographically are well suited for most farming operations. Natural drainage is adequate and thorough, and, in some of the Everett and Indianola soils, it is excessive. The moisture-retaining capacity of these soils varies greatly, depending largely on the texture of the soil materials. In the more sandy and gravelly soils, such as those of the Everett and Indianola series, it is greater than that of the soils with more compact or cemented subsoils. The tendency of some of the soils to be droughty is a serious limitation on their utilization during periods of low rainfall. Agricultural development is most extensive on the Kitsap soils which are finer textured and less loose and permeable than the other soils of this group.

Everett gravelly sandy loam.—Everett gravelly sandy loam is the most extensive member of the Everett series. In cultivated areas the surface soil, in most places, is dark grayish-brown loose gravelly sandy loam. In virgin areas a thin mat of partly decomposed forest litter over a thin very dark highly organic layer covers the surface soil, but under cultivation these materials disappear rapidly through decomposition or admixture with the light-colored mineral soil. The subsoil is a light-colored incoherent material to a depth ranging from 20 to 25 inches. Shot are present in both the surface soil and the subsoil. Underneath the subsoil is a thick deposit of sandy and gravelly material in the form of either a heterogeneous mass or stratified beds interspersed with lenses and pockets. In some exposures the substratum appears as poorly assorted material, and in others it shows well-defined layers. The material is somewhat compact, coherent, and resistant to crumbling, although no hardpan, similar to that in the Alderwood soils, is developed. A large quantity of grass roots are contained in the surface layer, and tree roots penetrate the underlying parent material in many places. The content of water-worn rounded gravel varies from place to place.

In some areas a transitional layer is apparent where this soil borders or merges with poorly drained soils. In such places the lower layers are mottled and, in places, shallow, resting, at a depth ranging from 4 to 6 feet, on material similar to that underlying the Alderwood soils. The varying composition of coarse- and medium-textured materials, such as gravel, sand, and silt, produces variations in texture. As mapped, patches of loamy sand and loam are included, but the dominant texture is sandy loam.

Also included on the soil map are a few areas, in which, at a depth ranging from 25 to 30 inches, a somewhat indurated or compact layer of sand and partly weathered gravel, coated with gray, brown, and reddish-brown cementing material, has developed. The thickness of this layer ranges from 6 to 15 inches. Its firm consistence is, in places, interrupted horizontally for a few feet by friable material. Below is a heterogeneous mass of gravel and sand showing stratification in many localities. In some bodies the included soil has a buff or light reddish-brown color which is intensified when moist. These included areas occur principally in the western part of the county south of Seabeck, but a small body lies northwest of Fragaria.

Everett gravelly sandy loam has fairly smooth or undulating relief, and elevations range up to 300 feet above sea level. The loose structure and gravelly nature of the soil allow free downward drainage and cause it to be somewhat droughty. In many places, especially at the higher elevations, difficulty is experienced in obtaining a supply of water in wells for domestic use. Large bodies of this soil occur in the southern and central parts of the county.

Less than 1 percent of the land is under cultivation. Most of it has been logged recently or is covered with a good stand of second-growth timber. Cultivation is limited to small fields or patches. General farming on this soil is not commonly practiced, owing to its natural droughtiness and lack of moisture during dry summers. With intensive cultivation, however, shallow-rooted crops, such as garden vegetables, potatoes, orchard fruits, and small fruits, respond with good yields. Strawberries are successfully grown on a small acreage of this soil on Bainbridge Island. Many farmers, whose farms include

Everett gravelly sandy loam, devote their time to poultry raising, buy most of the feed required, and cultivate only enough land necessary to produce garden truck for home use.

Everett gravelly sandy loam, flat phase.—Associated with typical Everett gravelly sandy loam in the southern part of the county are several areas mapped as a flat phase, which are smoother and more nearly level but in which the soil is otherwise similar to the typical soil, except in a few places where the texture is heavier and the moisture-holding capacity higher. Only a few farms include this soil. Cultural practices are the same as on the typical soil. Most of the land is forested or has recently been logged. Almost pure stands of lodgepole pine are developed on this soil.

Everett gravelly loamy sand.—Everett gravelly loamy sand differs primarily from Everett gravelly sandy loam in having a lighter and slightly more sandy texture, more porous structure, and more droughty character. In undisturbed timbered areas it is covered by a thin layer of forest litter, possibly 2 inches thick, which imparts a sandy loam or loam texture and dark-gray color to the uppermost 2 or 3 inches of mineral soil. Beneath is dark-brown friable gritty gravelly loamy sand or light sandy loam extending to a depth of 6 or 7 inches where it passes into yellow, brownish-yellow, or yellowish-brown loose loamy sand, in which the content of gravel varies. Shot are abundant in the upper part of the soil but become less numerous with depth. The substratum is composed of a mixture of gravel and gray sand, which is stratified in most places and unassorted in others. Small areas of gravelly loam or sandy loam are included in mapping, together with a few areas of transitional soils which border typical Everett gravelly loamy sand.

This soil occupies level or gently undulating terracelike benches or high plateaus, relieved here and there by knolls, depressions, and slopes. The productive capacity of the land is somewhat less than that of Everett gravelly sandy loam. The loose structure of the soil materials contributes to a natural droughty condition which is magnified during the dry summer season.

The largest bodies of this soil lie east of the State highway extending south from Port Orchard. Other large bodies are in the central and northern parts of the county, and a few, totaling several square miles, are on Bainbridge Island.

Although the total acreage of Everett gravelly loamy sand is large, its contribution toward the production of general farm crops is small. The operators of the few farms located on this soil are either absent a part of the year or obtain most of their income from commercial or industrial employment. Most of the cleared land is used for poultry raising, and the rest is devoted to the production of garden vegetables, some fruit, and a little feed for livestock. Returns are obtained from this land only through heavy applications of fertilizers, intensive cultivation on small areas, and careful conservation of moisture.

Everett gravelly loamy sand, steep phase.—Areas of Everett soils occupying steep broken slopes have been designated as Everett gravelly loamy sand, steep phase. In places, drainageways have cut steep V-shaped ravines. The slopes are subject to erosion, and part of the surface soil in some cleared areas has been carried to lower elevations. The texture, depth, color, and structure of the various layers

are not uniform, but these differences are of small importance, as the soil has practically no agricultural possibilities except for pasture. The greater part of this steep land is still timbered or has been logged recently. Some of the steep bluffs bordering the coast are included with this soil in mapping.

Indianola loamy sand.—The surface soil of Indianola loamy sand is dark-brown or brown open porous loamy sand containing a moderate quantity of cemented shot about the size of peas. In undisturbed virgin areas a thin dark-colored mat of undecomposed or partly decomposed forest litter, about 2 inches thick, overlies the surface soil. Under cultivation this organic material quickly decomposes or mixes with the mineral soil. The surface soil is underlain, at a depth of about 8 inches, by pale-yellow or light brownish-yellow loamy sand, in which the shot are less abundant. This grades into lighter gray somewhat more compact or coherent loamy sand containing pockets or lenses of fine sandy loam. At a depth ranging from 3 to 4 feet this material, in turn, grades into light-gray and light-yellow looser sandy and fine sandy material which assumes a pepper-and-salt color and is irregularly stratified or cross-bedded in the lower part. The soil in an area south of Annapolis has a somewhat coarser sandy texture. Included variations in texture, thickness of layers, color, and structure are of small importance and have little influence on the natural fertility and productive capacity of the soil.

The soil is characterized by freedom from gravel and cobblestones, although some stony fragments are scattered over small spots or in places where this soil merges into areas of the Everett and Alderwood soils. The surface soil is mildly acid.

The relief ranges from smooth to undulating, and some areas are slightly rolling. Drainage is thorough in the upper layers, but underdrainage is not so rapid, owing to compaction of the subsoil. The water-holding capacity is slightly better than that in the Everett soils. The physical features of the soil favor free development of the rooting systems of plants.

Indianola loamy sand is widely distributed in narrow comparatively short belts along or near some of the streams and drainageways. The largest development extends intermittently from Port Gamble (bay) to Kitsap.

Scattered small areas of this soil have been cleared and put into cultivation. The soil is not highly esteemed by farmers who consider it to be too dry in most places. Yields of general farm crops are below the average for the county. Some of the land is utilized for the growing of small fruits, such as strawberries, apples, and truck crops, yields of which vary according to seasonal conditions and systems of management. Most of the land is covered with timber or has been logged. No attempt is being made to clear additional land. Many farmers, established on this soil, devote their time to raising poultry, and with them cultivation of the soil is generally a secondary consideration.

Indianola loamy sand, steep phase.—The steep phase is differentiated from typical Indianola loamy sand on the basis of its position on slopes steep enough to reduce the value of the land for cultivated crops and to render it unsuitable for the use of ordinary farm machinery. When cleared, the slopes are subject to destructive erosion.

The profile characteristics of the steep soil are essentially similar to those of typical Indianola loamy sand except for more pronounced differences in the thickness of the layers. With the exception of a small cleared acreage, some of which is used for pasture, the soil supports a forest cover composed principally of evergreens.

Indianola fine sandy loam.—Indianola fine sandy loam contains more fine sand, very fine sand, and silt particles than does Indianola loamy sand, and the result is a slightly finer and heavier texture. The thin dark fine sandy loam surface soil is underlain by grayish-brown fine sandy loam, in which the content of shot is variable. Below a depth of 6 or 7 inches and extending to a depth ranging from 18 to 24 inches is yellowish-brown or brownish-yellow fine sandy loam or very fine sandy loam, the upper part of which is mixed with small hard rounded iron concretions. Beneath this are irregularly developed and intricately associated layers of gray and yellow very fine sandy loam, fine sandy loam, and silty material, splotched with iron in a few places.

The areas of Indianola fine sandy loam are small and scattered, chiefly throughout the northern part of the county. This soil is not so loose and open as are other members of the Indianola series, and it has a somewhat better moisture-holding capacity.

Some truck crops, small fruits, potatoes, oats, and hay are grown on only a small part of the land and in small patches, and yields range from low to fair. This soil has potential value for the growing of general farm crops and vegetables, but the small areas, difficult accessibility, cost of clearing, and limited rainfall during the growing season are unfavorable factors to be considered carefully in its further development.

Kitsap silt loam.—The surface soil of Kitsap silt loam, in cultivated areas, is about 8 inches thick and consists of brown or grayish-brown granular silt loam, through which shot are scattered. In undisturbed forested areas it is covered with a layer, about 2 inches thick, of undecomposed organic forest and plant litter which grades into a thin transitional layer of mixed mineral and decomposed organic matter. The subsoil is yellowish-brown or brownish-yellow smooth-textured silt loam containing fewer shot than the surface soil. This grades, at a depth of about 18 inches, into compact light-brown or brownish-gray silt loam spotted with darker brown. This material, in turn, gradually changes to gray floury silt loam, in which there are laminations and layers of fine sandy, silty, and clayey materials. In some places the soil includes small undifferentiated areas of Kitsap very fine sandy loam and Indianola soils.

This soil is distinguished by its smooth fine texture and general freedom from grit, gravel, or cobblestones. The upper part of the soil is moderately well supplied with organic matter, and this accounts for its dark-gray color. Everywhere, shot are present in the surface and subsurface layers, and, in places, they are sufficiently abundant to impart a porous and loose structure to the material. The large content of small plant roots also aids in imparting a granular structure to these layers. From the lower part of the subsoil downward, the compaction of the material is sufficient to retard the rapid downward percolation of ground water. A saturated layer, formed in places above the compacted material, has caused

some leaching of soluble compounds and has produced the stained appearance in this layer. The stratified structure of the substratum, together with the irregularity of the laminations of silt, very fine sand, and clay, has brought about local variations in the texture and water-retaining capacity of the soil. Surface drainage is adequate, and underdrainage in most places is good. The capacity of the soil to hold moisture is greater than that of the Everett and Indianola soils, owing to the finer texture and more compact character.

Small areas of this soil are scattered throughout the county on the higher benches in valleys, in narrow long belts bordering the bluffs along the coast, or in small strips along drainageways. The largest body is the one along the highway from Brownsville to East Bremerton. The soil is associated with the Alderwood, Everett, and Indianola soils. The relief is level or very gently undulating and favors easy cultivation of the land.

Kitsap silt loam is one of the most fertile and desirable agricultural soils in the county. Cultivation of the land, however, is confined to small-scale farming in small units. Oats, wheat, and hay are the main crops in the rotation. Dairying, supplemented by some truck and small-fruit gardening, is the chief system of agriculture followed. Yields of crops usually are above the average for the county.

Very little commercial fertilizer is used on this soil, and that used is generally applied to land to be planted to grains and vegetables. The main soil amendment is stable manure. A short rotation of crops is practiced to some extent, involving the alternation of grain and hay. Due to its greater natural fertility, the chances for good returns from cultivated crops on Kitsap silt loam exceed those on the Indianola and Everett soils. The greater part of the farm income on this soil, however, comes from the sale of poultry and dairy products.

Kitsap silt loam, steep phase.—Kitsap silt loam, steep phase, occupies steep slopes along draws and areas facing narrow stream valleys. Most of the slopes are smooth, although, in places where there is a series of such slopes, the land is gullied and uneven in places. This steep land is well drained. The local acreage and agricultural importance of the soil is small, and most of the land is in forest. Small patches have been cleared and used for pasture, but the greater part is too steep for practical farming operations.

Kitsap silt loam, imperfectly drained phase.—The imperfectly drained phase of Kitsap silt loam, under a timber growth, has developed a 2- or 3-inch surface soil of dark-gray or dark brownish-gray silt loam containing a large quantity of organic matter. This material is abruptly underlain by light-brown or brownish-gray silt loam or silty loam containing dark iron-cemented shot, in most places in large quantities. This material, in turn, is underlain at a depth of 8 or 10 inches by light-gray, light yellowish-gray, or nearly white smooth silt loam streaked with iron-colored stains. The color fades with depth, and below a depth of 24 or 26 inches the material grades into the substratum of stratified layers of gray silt, clay, and some very fine sand. These layers have been deposited in thin seams and are smooth, floury, and gritless.

The parent materials of this soil are similar to those of typical Kitsap silt loam, but the imperfectly drained soil, as its name implies,

has developed under more imperfect drainage than that characterizing the typical soil. Leaching of soluble mineral matter is evident in the gray and mottled coloration of the upper part of the soil. The relief is undulating, slightly uneven, or flat, and slight differences in soil are associated with differences in elevation and drainage. On the tops of knolls and hummocks the soil approaches typical Kitsap silt loam in color, but in depressions and on slopes subject to seepage where oxidation has been retarded, the soil is grayer, more mottled, and more poorly drained than that soil.

As mapped, this imperfectly drained soil includes variations in color and texture and small patches of typical Kitsap materials. One of the more prominent inclusions is an area of heavier textured and darker colored soil on slopes and flats south of Blakely Harbor on Bainbridge Island. The uppermost 1 or 2 inches of the included soil is dark-gray heavy silt loam or silty clay loam and is underlain by dingy-gray or brownish-gray heavy silty clay loam or light clay loam, streaked with yellow. At a depth of about 15 inches the material is lighter colored heavy silty clay loam or silty clay mottled with rusty yellow, which grades at a depth of 20 or 23 inches into dull-gray or gray heavy tight slightly plastic gritless clay mottled with brown and rusty yellow. The deep substratum of the included soil is less plastic and more crumbly than the overlying material.

Surface drainage of Kitsap silt loam, imperfectly drained phase, is good, but internal drainage is deficient, owing to the compact structure and heavy texture of the material and its topographic position. In some places the unsatisfactory drainge results from seepage from higher land.

Because of its small extent and scattered distribution in the northern part of the county, this soil has no marked agricultural importance. It does, however, furnish desirable pasturage. Only a few small tracts are cleared and devoted to cultivated crops, principally oats, vegetables, hay, and potatoes. On most farms the soil is tilled in connection with adjoining soils and is similarly managed.

Alluvial soils, undifferentiated.—Alluvial soils, undifferentiated, include the alluvial sediments of stream bottoms, strips paralleling the streams, and depressions in the uplands. Most of the strips range from 100 to 200 feet in width, but in a few places they are from one-eighth to one-fourth mile wide. Abandoned stream beds and gravel wash are included under this designation. Most of the material is derived from deposits of alluvium, but some of it consists of fine sediments washed from adjacent slopes.

This material is too variable in color and texture to be separated consistently into soil types. For the most part, the surface soil is dark grayish-brown, dark-gray, or nearly black material with a sandy loam, loam, silt loam, or clay texture. The upper part of the subsoil varies widely in texture but in most places is gray, highly mottled with rusty yellow and rusty brown, and the lower part is gray or drab water-saturated, fine-textured, somewhat compact material. In some areas a layer several inches thick of dark-brown or black muck or peat overlies the soil, and in other areas the surface soil grades, at a depth ranging from 12 to 25 inches, into dark-gray or almost black, smooth, well-decomposed organic matter interbedded with masses of brown felty fibrous peat. Within a few feet of the banks of streams

the material generally is more sandy and the mineral matter is thicker than it is farther back.

The relief of this land is smooth or nearly level. Drainage is poor or deficient, and swales and small saucerlike basins bordering the upland slopes remain saturated the greater part of the year.

Most of this land is thickly forested with alder, willow, and conifers. Grasses and moisture-loving plants form a dense undercover. None of the land has been drained, but if it were properly drained it would support a good stand of grasses and produce high yields of hay. A few small cleared tracts are used for pasture, hay, and garden truck.

ORGANIC SOILS

Organic soils comprise materials derived from native bog and swamp vegetation in various stages of decomposition, in which the organic materials dominate mineral soil materials. They are separated into types on the basis of differences in character of parent vegetation, stage of decomposition, and profile development (*2*, *3*). In this group are three types of peat, which consist mainly of organic materials, contain little or no mineral soil material, and in which parent plant remains are only partly decomposed and are capable of identification, and one type of muck which represents a more advanced stage in decomposition and contains a larger proportion of mineral soil material.

Greenwood peat.—Greenwood peat is a brown or grayish-brown raw fibrous felty matted mass of vegetable matter consisting mainly of mosses. The immediate surface layer consists of alternating spots, a few feet in diameter, of dark-gray partly decayed vegetable matter and of recent accumulations of leaves and stems from the covering vegetation. From the surface downward the material is in the form of thin interlocking layers representing the annual accumulations of dead vegetation, some of which has undergone change, but the greater part of which retains its original physical character and outline. Its chemical composition has been changed, and it is strongly acid. The thickness of this type of peat ranges from very slight on the outer edges of areas bordering mineral soils to more than 2 feet in the interior.

The vegetation entering into the composition of Greenwood peat consists mainly of water-loving plants. In the larger areas, sphagnum moss, cattails, sedges, and wire grass grow in the center, surrounded by cranberry and huckleberry bushes, spiraea, bog rosemary (*Andromeda polifolia*), leatherleaf, and other shrubs. A heavy growth of shrubs, ferns, and trees borders most of the areas. A few areas support a scattered tree growth in the interior, but the influence of trees on the composition of the soil material is negligible. In a few places, however, the remains of tree roots and stumps, in the form of punk, are present in the lower part of the soil.

Most areas of this land are waterlogged the greater part of the year. The water table lies close to the surface, and water sometimes covers the land to a depth ranging from 2 to 4 inches.

Areas of Greenwood peat are widely scattered and range from less than 1 to more than 100 acres in size, but most of them are small. This type of peat has no present agricultural use except for an occa-

sional harvest of wild cranberries, and most of it remains in its natural state.

Rifle peat.—The material composing Rifle peat is in a more advanced stage of decomposition than that composing Greenwood peat. The surface layer, to a depth ranging from 6 to 12 inches, is permeated by a mass of matted plant remains in various stages of decay. Woody peat composes the topmost layers and tends to develop a granular structure. When wet, the material is almost black and has a soft smooth feel, but, when dried, it is dull gray and displays a tough felty strongly matted structure. Beneath this layer is less well decomposed dark-brown or almost black peaty matter which becomes lighter colored, coarser, and more fibrous with depth. The material in the lower part contains a much larger proportion of sedge, grass, and purely aquatic plant remains than the overlying layers. In most places the thickness of the peat material is about 2 feet, but in some places it extends downward to a depth of 8 feet.

Rifle peat supports a growth of mixed hardwoods and conifers, with an undergrowth of ferns, woody shrubs, mosses, sedges, and grasses.

The water table fluctuates greatly, according to rainfall, but, on the whole, it is lower than that of Greenwood peat. This allows greater oxidation and consequent decay of the organic matter. Small areas of Greenwood peat are associated with Rifle peat in some places where the water table is consistently high and the outlets of the depressions are restricted.

A few small tracts of this type of peat have been cleared, ditched, and prepared for cultivation. Vegetables, including peas, tomatoes, carrots, potatoes, celery, and cabbage, are grown successfully. Most of the cleared land is used for pasture, and wild hay is cut from a few fields. The greater part remains in forest.

Spalding peat.—Spalding peat is an organic soil intermediate between Greenwood peat and Rifle peat, with regard to depth of water table, degree of decomposition of the parent plant material, color, and utilization. The topmost 2 or 3 inches of Spalding peat are dark grayish-brown or brown raw felty loose-structured spongy organic matter recently formed from dead leaves, stems, and roots of sedges and swamp grasses mainly, although some shrubs, like spiraea, and occasional trees may have contributed material in a few places. Beneath this layer is dark grayish-brown or dark-brown laminated or matted felty compacted vegetable matter containing a large quantity of small plant roots. This material is darker than that in the layer above or below. A part of the vegetable matter is well decayed and has a smooth colloidal structure. The material in this layer grades, at a depth ranging from 8 to 12 inches, into a grayish-brown or brown raw felty fibrous spongy mass of sedge material which contains a few interbedded layers of dark material similar to that in the subsurface layer but much less advanced in stage of decay. The original forms of stems, leaves, and roots are more readily identified than those in the overlying layer.

Some areas of this peat are open, others support a scattered tree growth, and still others have been cut over. None of the land, however, is cleared for pasture or cultivation.

Muck.—Muck as mapped in this county has developed from grasses, sedges, ferns, wood, and other vegetable matter in fairly well ad-

vanced stages of decomposition. The decayed vegetable material is mixed with small quantities of mineral matter, such as very fine sand and silt, and in many places rests at a depth of less than 2 feet on mineral matter which commonly is light-gray smooth comparatively impervious heavy clay. In many places the structure is granular, owing to the presence of small subangular pieces of decayed wood. The organic matter in most places is almost nonfibrous or very finely divided, but in a few places it may resemble peat, in that it consists of partly decayed plant remains. As mapped muck includes a few small areas in which the surface material is definitely of peatlike character but is underlain at a slight depth by the mineral subsoil.

A thick junglelike growth of alder, fir, hemlock, cedar, salal, ferns, willow, and madrona covers most of the land. This land, the greater part of which occurs near Erland and between Keyport and Bremerton, at present is not utilized for any purpose.

MISCELLANEOUS LAND TYPES

The group of miscellaneous land types comprises rough mountainous land; steep broken land; coastal beach; coastal beach, terrace phase; and tidal marsh.

Rough mountainous land.—The designation, rough mountainous land is applied to areas of undifferentiated soils which, on account of rough relief, stoniness, rock outcrop, steep slope, and shallow soil, are dominantly nonarable. A very few small and isolated patches of soil are cultivated. The thin mantle of soil material over the underlying rock varies greatly within short distances. In some of the areas dominated by parent bedrock material it resembles the Melbourne soils, whereas in others dominated by thin glacial drift materials it represents shallow Alderwood or Everett soils. In mapping, isolated patches of typical Alderwood loam and Everett gravelly sandy loam, along and at the heads of some of the drainageways, are included. All these soils are intricately mixed, however, and rock outcrops, varying drainage conditions, and broken relief further confuse their pattern. Stones range from small gravel to massive boulders and ledges. The principal underlying rocks are granite, sandstone, basalt, shale, quartzite, and conglomerate.

This land occurs only in an extensive area west of Bremerton, known as the Blue Hills. Some of the land has been logged recently, but a large part is covered with a heavy stand of second-growth trees, including fir, hemlock, cedar, and alder. Salal, ferns, huckleberry, rhododendron, Oregon grape, and vines are the most conspicuous plants in the dense undergrowth. This land has little value except for forest and limited pasture. So long as other more productive land is available, the agricultural development of these rough mountainous areas is not economically justified.

Steep broken land.—Steep broken land comprises a variety of unclassified and undifferentiated soils along and around the heads of some of the drainageways and on the bluffs and escarpments bordering the coast line, of which the outstanding feature is a steep and broken relief. The variable soil material includes developments similar to the Indianola, Alderwood, and Everett soils. Each of these, with textural variations, dominates a small area and gives way to another soil condition.

None of this land is cultivated. Most of it is in forest and some is used for pasture. It is best suited to these two purposes. Erosion has been and still is active, and cultivation would increase this danger.

Coastal beach.—The material forming beaches and bars along the shore of Kitsap Peninsula and Bainbridge Island is mapped as coastal beach. It consists mainly of an assortment of gravel, cobblestones, and sand, and to less extent of gray sand a few inches deep over gravel. It has been built up by the combined action of waves, shore currents, and wind. The beaches lie from 3 to 10 feet above the normal level of the tide and range in width from 10 to 300 feet. Many areas are too small to indicate on the soil map and have been represented by the shore line or included with adjoining soils. This class of material has no agricultural value.

Coastal beach, terrace phase.—The topmost material of the terrace phase of coastal beach consists of a 1- to 3-inch layer of dark-gray or nearly black loamy sand and gravelly material. It is underlain by brown, yellowish-brown, or brownish-yellow sand mixed with a large quantity of gravel. At a depth ranging from 20 to 25 inches is a grayish-brown mixture of stratified sandy, gravelly, and finer textured soil materials. In a few small areas the surface soil is very dark gray or nearly black and contains much organic matter, and the subsoil is mottled yellow and gray. Between the two conditions described are minor variations in color, but the material is mainly a heterogeneous mixture of gravel and sand, slightly altered by environmental agencies.

This type of material is developed along the coast in the vicinities of Waterman, Manchester, Gibson, and Blakely Harbor, in a few scattered terrace or benchlike positions which lie from 10 to more than 30 feet above sea level and range from 100 to 200 feet in width. Some of the land has been cleared for summer resorts, and small patches are used for garden truck in connection with them. The rest is undeveloped and is covered with a growth of alder, willow, cedar, bracken, huckleberry bushes, and other plants.

Tidal marsh.—Tidal marsh consists of low-lying coastal areas, locally known as mud or tidal flats. Although they are waterlogged most of the time, they are covered by water only during high tide. The material, in some places, is mineral soil composed largely of silt, clay, and some fine sand, and it contains a variable quantity of salts; elsewhere the material is partly decomposed organic matter ranging from 10 to more than 30 inches in thickness.

Some of the tidal marsh supports a growth of reeds, rushes, coarse grasses, and other water-loving vegetation. A few trees grow on the outer edges of areas bordering the upland. Individual bodies are only a few acres in size, and their total acreage is small. A few patches have been ditched and diked for pasture and hay land, but the greater part is salty and undeveloped, owing to the difficulty and cost of reclamation.

MORPHOLOGY AND GENESIS OF SOILS

Kitsap County is included in a much earlier reconnaissance soil survey (*5*). In this early survey all the upland soils were included with the Everett series, whereas the lowland alluvial areas were included with the Bellingham series. In the present survey the soils

have been studied and mapped in much greater detail, in order to show their diversity or range in texture, structure, moisture-holding capacity, drainage, chemical composition, and natural fertility, all of which bear close relationship to plant growth, soil management, and agriculture.

The soils are rather immature, most of them having developed on or from the mantle of glacial drift deposited during the last glaciation, and their characteristics are still largely determined by the character of the parent material.

The rock fragments contributing to the glacial accumulations have been derived from a number of geological formations. Many of them have come from igneous rocks and interbedded sandstone and shales from the north during the advance of the last glacier into the Puget Sound Basin. These are intermixed with materials from granite, basalt, conglomerates, sandstone, shales, and other rocks of more local occurrence.

While morainic deposits were being accumulated in the northern and other parts of the county, waters loaded with sand, silt, and gravel sediments were issuing from the melting ice and depositing these materials in the form of outwash plains or in temporary glacial lakes, parts of which were subsequently overridden and modified here and there by the ice. The larger belts of outwash materials were accumulated in the southern part of the county, but small bodies formed elsewhere adjacent to ground moraines. A large proportion of the materials comprising the morainic areas is finer than the materials of the gravelly and sandy plains, and soil-building agencies have been more active on them in producing the horizontal layers of a soil profile.

The dynamic forces of soil development acting on these various masses of glacial debris have produced most of the different kinds of soils now covering the county. Of these environmental forces the most important are climate, especially rainfall, and vegetation. These forces may be hindered or arrested in influence through restrictions imposed by poor drainage, unfavorable relief, and resistant parent material.

The soils have developed in a forested region under the influence of a climate characterized by mild, even temperatures, and moderately heavy rainfall modified by mountain ranges and marine influences. They fall under the category of the Gray-Brown Podzolic soils in which the podzolic character, however, is only feebly expressed.

Where drainage was good or fair, the soils developed under a dense forest cover unfavorable to the growth of grass and the accumulation of organic matter in the soils. These soils are, therefore, light colored. Under these conditions, the soil materials have undergone such chemical, physical, and biological changes that the original geologic characteristics have, in part, been obscured by acquired characteristics. The original vegetation consisted of a heavy stand of conifers, mainly Douglas fir, hemlock, spruce, and cedar, mixed with some deciduous trees, mainly alder and western maple. Salal, Oregon grape, bracken, huckleberry bushes, rhododendron, and a variety of mosses formed a dense undergrowth.

The climate of this section is oceanic with short moderate winters and cool summers. Important elements of the climate are the large number of cloudy and rainy days in proportion to clear days. Rain-

fall increases rapidly toward the Olympic Mountains on the west where the annual precipitation is as heavy as 100 inches. The mean annual precipitation for the county is about 38 inches.

Aside from an area with steeply rolling or hilly and mountainous relief in the southwestern part, the land is smooth, strongly undulating, or gently rolling. Drainage is generally fair to good and is deficient in only a few areas.

A study of virgin soils throughout the section of undulating relief and good natural drainage reveals certain common characteristics. Here, the processes of soil development have been active for a comparatively long time and have not been disturbed by a high water table or serious erosion. The effect of environment is expressed in the following general features of the mature and normally developed soil of the section:

1. A 2- or 3-inch layer of recently accumulated forest litter.
2. A ⅛- to ½-inch layer of nearly black leafmold.
3. A 1- or 2-inch layer of dark-brown fine-granular material.
4. A 6- to 10-inch layer of grayish-brown or dark-brown material with a single-grain structure, containing a large number of rounded hard dark pellets of iron-cemented material, or shot (7), about the size of peas or smaller.
5. A 15- to 20-inch layer of pale-yellow material which is slightly lighter textured and contains fewer shot below the first 5 or 10 inches than the overlying material and which becomes lighter colored with depth.
6. A 6- to 15-inch layer of gray indurated or slightly compact material which rests on the parent material.

This profile differs from that of a typical Podzol (*4*, *6*) in the thinness of the overlying layer of forest litter, the absence of a distinctly developed gray horizon in the upper part of the soil, and the lack of an ortstein layer. The soil may be considered as a podzolic soil or a weakly developed Podzol. In the moist depressions, a thin gray podzolic layer, from one-sixteenth to one-eighth inch thick, is developed in a few places beneath the layer of humus.

The origin of the siliceous hardpan in the soils of this section has been a subject of some speculation. No explanation of the process of development will be attempted here, but it seems reasonable to suppose that the hardpan is a developed subsoil horizon rather than a layer of the substratum or the parent material from which the soil has developed. The comparative uniformity of depth of soil above it seems sufficient evidence to support this conclusion. It appears that a temporary or intermittent water table may be responsible for the condition. The rainfall in this section is heavy in winter; it comes in gentle long-continued showers, and probably very little runs off the surface. This combination of conditions very probably causes a high ground-water level during the rainy season and is the cause, not the effect, of the hardpan layer.

The soils of this county are classified in two groups: (1) Those with strongly indurated hardpanlike subsoils or substrata and (2) those with friable or only slightly compact subsoils. These two groups nearly everywhere are further distinguished by two types of relief. Soils with highly compacted or indurated layers have developed on the broad undulating or gently rolling ridges and valley slopes, whereas the soils with friable subsoils occur almost entirely on the smoother plains and lower valley slopes.

The most extensive and best developed representative soils with indurated layers are the Alderwood which occupy well-drained broad

ridges and valley slopes. Although the Alderwood soils are far from reaching a stage of complete soil development, they have distinct horizons and characteristics representative of the distinctive profile of the region (*1*). The following description of a profile of Alderwood loam, as observed three-fourths mile east of Fletcher Bay on Bainbridge Island, is typical of this series. The virgin soil is covered with a surface layer, about 3 inches thick, of forest litter composed of leaves and stems from conifers and, to less extent, from deciduous trees and salal, ferns, and small bushes, resting on a layer, about one-half inch thick, of forest mold which is mottled and consists of partly disintegrated and decomposed leaves and other plant remains.

1. 0 to 2 inches, dark grayish-brown fine-granular friable gritty loam containing much organic matter and a quantity of hard rounded shot, about the size of buckshot or peas.
2. 2 to 8 inches, rich-brown or pale reddish-brown friable loam containing a large quantity of iron-cemented shot similar in size and firmness to those in the layer above. Most of the shot are coated with a thin film of soil which obscures their dark rusty-iron color. The soil and shot are held in a coherent mass by an abundance of small plant roots that extend through this layer.
3. 8 to 21 inches, brownish-yellow or pale yellowish-brown gritty loam which is slightly lighter textured and contains fewer shot than the overlying layer. It has a single-grain structure. The color in the lower part of this layer fades gradually. Scattered through the material are occasional small incipient concretions.
4. 21 to 28 inches, gray friable loam mottled with yellow and light gray. This is a transitional layer of mottled color development, and the color and extent of mottling vary within short distances. Plant roots that grow through this layer form a thick heavy tangled interlocking mat over the underlying layer.
5. 28 to 38 inches, a light-gray or ash-gray indurated or strongly cemented hardpan layer of heavy loam texture, showing a platy or thinly laminated structure. The hardpan is very resistant to fracture, but, once broken, it crumbles into a friable mass. Plant roots do not penetrate this layer but form a dense mat over the top.
6. 38 to 60 inches+, gray or dingy-gray softly cemented or firmly compacted loam parent material.

Scattered over the surface and through the soil are various quantities of granite, sandstone, shale, quartzite, basalt, and other stone fragments, ranging in size from small gravel to boulders 2 feet or more in diameter. The quantity of stone fragments in most places, however, is not sufficient to warrant separation of the soil into stony or gravelly types. Peculiar features of the soil are the accumulation of small, hard shot in the upper layers and their general absence in the lower layers. The normal podzolic light-textured A horizon and heavier textured deeper colored B horizon are not developed. Little change in texture takes place from the surface soil down to the indurated layer. The surface and subsurface lavers appear slightly more loamy, owing to the incorporation of organic matter, and are slightly more coherent than the material above the hard zone.

Alderwood fine sandy loam and Alderwood loamy sand have the same color and structure as Alderwood loam, but they contain less organic matter and slightly fewer shot than that soil. The open structure resulting from the sandy character of these soils, together with the abundance of shot, allows good drainage and rapid oxidation of the humus.

Sinclair loam is associated with the Alderwood soils, but the relief is smoother and drainage of this soil, owing to its occurrence in posi-

tions subject to seepage, is poorer. During rainy periods, this soil remains wetter for longer periods and consequently has a grayer, more leached appearance than any Alderwood soil. Though its texture and profile resemble those of Alderwood loam, Sinclair loam is distinguished by the grayer color of the surface and subsurface layers and by a much larger content of shot which, in places, makes up 50 percent or more of the material comprising the upper layers.

The Edmonds soils also are characterized by the development of cemented hardpanlike substrata which, however, have a different genesis from those of other members of this group. These are sandy soils occupying terraces and benchlike positions within valleys, where they have developed under the influence of a fluctuating high water table or seepage. They represent ground-water podzolic soils developed under hydromorphic conditions. Edmonds loamy sand has a thin grayish-brown surface layer over a light-red or yellowish-brown subsurface layer containing a moderate quantity of shot. The subsoil is gray, mottled with yellow and brown, sandy material, in which there are small hard indurated masses or lenses of dark material stained with rusty yellow and rusty brown. This layer grades into a firmly compacted or cemented yellow and gray sandy ortstein zone from 8 to 12 inches thick, and thence into the parent material of gray and yellow compact sands. Edmonds fine sandy loam is a more poorly drained equivalent of Edmonds loamy sand and has a very dark gray surface layer, from 10 to 15 inches thick, underlain by light-gray sand that grades into layers similar to the subsoil and substratum of Edmonds loamy sand.

The essential features of the typical soil profile of a well-drained soil with a friable subsoil, in which oxidation and leaching have been effective to depths ranging from 40 to 50 inches, are displayed by members of the Everett series. Following is a description of a profile of Everett gravelly loamy sand, as observed one-half mile south of Bethel:

1. 0 to 2 inches, dark grayish-brown gravelly loamy sand thoroughly mixed with organic matter. In undisturbed forested areas this layer is covered by a thin layer of a dark-brown or nearly black mixture of leafmold, forest litter, and partly decayed leaves from a mixed growth of conifers and deciduous trees, among which the undergrowth is thick and includes salal, ferns, brush, and grass.
2. 2 to 6 inches, dark-brown gravelly loamy sand, in which are distributed a small quantity of small hard cemented pellets, or shot, about the size of buckshot or peas. Small grass roots bind the granular soil material into a coherent mass. The dark color is imparted largely by finely divided organic matter derived from the decay of plant roots and plant remains and thoroughly mixed with the mineral soil.
3. 6 to 22 inches, a dull-yellow or light brownish-yellow mixture of loamy sand and small rounded gravel of loose consistence.
4. 22 to 26 inches, yellowish-gray slightly coherent sand and gravel.
5. 26 to 30 inches, a gray sandy gravelly layer, in which the material is slightly compact in place.
6. 30 to 41 inches, a salt-and-pepper colored mixture of medium and coarse loose-structured sands.
7. 41 to 49 inches, heterogeneous beds of small rounded gray gravel and gray sands.
8. 49 to 60 inches, slightly compact and coherent gray medium and coarse sands containing small grains of dark-colored minerals.

The profile of Everett gravelly loamy sand illustrates the irregular layering and heterogeneous character of the parent material. This

soil has dark-colored surface and subsurface layers as the result of incorporation with organic matter. Everywhere associated with these layers is an accumulation of rounded iron-cemented shot which is strongly resistant to crushing. Underneath, the soil material has a contrasting lighter color which shades to still lighter colors with depth. An irregular mixture of small gravel is scattered over the surface and throughout the soil. The subsoil is composed of a combination of bedded and unassorted gravel and sands which is more or less coherent and compact in place.

The Kitsap soils are distinguished from the Everett soils by their freedom from gravel and grit, smooth fine texture, and their parent material which is composed of interbedded layers of silt, clay, and very fine sand.

A characteristic profile in a representative development of Kitsap silt loam, 1½ miles north of Burley, shows the following layers:

1. 0 to 2 inches, an organic accumulation of leaves and stems in an early stage of decay, derived from a tree cover including alder, fir, cedar, and maple, and an undergrowth of bracken, swordfern, salal, moss, and vines.
2. 2 to 4 inches, a mixture of fine-textured soil material and humus, to which a dark color is imparted from the overlying decomposed forest litter.
3. 4 to 8 inches, brown or grayish-brown granular silt loam containing an abundance of small rounded hard shot. The presence of shot is characteristic of the soil, and the pellets are most abundant in this layer.
4. 8 to 17 inches, yellowish-brown or brownish-yellow smooth gritless silt loam containing a few gray stains and, in the upper part, a few shot.
5. 17 to 23 inches, compact light-brown or brownish-gray silt loam containing light-gray stains and some thin layers of clay.
6. 23 to 40 inches, gray or light-gray smooth floury gritless silt loam streaked with thin seams or spots of brown. This layer is made up of thin laminated layers slightly compact in place, between which, in places, are paper-thin seams of very fine sand.
7. 40 to 60 inches, light-gray compact very fine sand mottled with yellow or brown. The material is laminated in thin layers but includes, in places, thin seams or stratified beds of gray fine sands, silts, and clays.

The Indianola soils have dark-colored thin sandy surface soils and brown subsurface layers that merge gradually into lighter colored gravel-free sandy materials. The parent material is a mixture of gray sands deposited mainly in stratified layers.

Indianola loamy sand has developed several distinct layers, which may be described, as observed in a representative exposure in a vertical profile in a timbered area, as follows:

1. 0 to 2 inches, forest debris derived from leaves and stems of fir, white pine, some alder, and cedar, and from an undergrowth of salal, moss, Oregon grape, ferns, huckleberry bushes, grass, and vines.
2. 2 to 8 inches, dark-brown or brown loamy sand containing a moderate quantity of hard iron-cemented shot or concretions about the size of peas.
3. 8 to 22 inches, pale-yellow or light brownish-yellow loamy sand having an open structure and containing fewer shot than the layer above.
4. 22 to 40 inches, light-colored material consisting of yellowish-gray or pale grayish-yellow coherent moderately compact loamy fine sand and sand and small pockets or lenses of brown fine sandy loam.
5. 40 to 70 inches, lighter gray or pale-yellow material which is lighter textured than that in the overlying layer and which is irregularly streaked with gray and brown. It includes mixtures of medium sand and very fine sand, and is somewhat compact in places. The lower part or deep substratum is a pepper-and-salt colored mass of medium sand and fine sand, compact in place. In many places the material is stratified and cross-bedded.

Shallow soils developed on interbedded sandstone, shale, and conglomerate rocks and old cemented gravel are included with the Melbourne soils, although the surface soils are darker and the profile differs from the Melbourne soils which are extensively and typically developed in the coastal section of Oregon and Washington and described in previous soil surveys.

The recent alluvial soils occupy small areas in which both texture and character of the soil vary markedly within short distances. They are poorly drained, for the most part, have dark-colored surface soils and gray or drab subsoils mottled with iron stains, and have no consistent profile. For purposes of mapping and discussion, they have been classified as alluvial soils, undifferentiated.

Organic soils are represented by three types of peat and one type of muck. They are inextensive and of little agricultural significance.

SUMMARY

Kitsap County occupies a part of Kitsap Peninsula on the west side of Puget Sound. The climate is influenced by the moist winds and modifying effect on temperature of the Pacific Ocean and Puget Sound and is characterized by a large number of cloudy and rainy days and a moderately high annual rainfall. Seasonal distribution of precipitation is variable, but rainfall is heaviest in fall and winter and light in summer. The average rainfall during the summer is about 2½ inches which is unfavorable for the development of a system of general farming and has tended to develop special forms of agriculture, such as the growing of vegetables and small fruits, poultry raising, and dairying.

This county covers a part of an undulating dissected plateau area, over which a mantle of varying thickness of glacial drift has been deposited. The glacial accumulations, both ice-laid and water-laid, are composed of materials formed from disintegrated underlying local rocks, including granite, sandstone, shale, conglomerates, and basalt, mixed with debris brought in from more distant sources.

The county occupies part of a broad soil belt in which the soils were developed under a dense forest cover and moist temperate climate. The original forest cover was a heavy growth, principally of conifers, such as Douglas fir, western hemlock, cedar, and spruce, together with some hardwoods, as alder and maple.

Poultry raising and dairying dominate the agriculture. The main income of most farmers is derived from poultry products, the value of which exceeds the combined value of all other farm products. Dairying is well established on a small scale and is an important source of income for some farmers. Corn, wheat, oats, and other grains are grown on a small acreage. The greater part of the acreage of cleared land is used for grazing and pasture. A fair income is derived from the sale of vegetables, small fruits, and tree fruits, produced on a small acreage.

Very little land is utilized for farming. The average acreage of improved land a farm is less than 10 acres, and only a few of these are devoted to crop production. This lack of agricultural activity is due, in part, to the low rainfall during the growing season and the high cost and length of time necessary to clear the land for cultiva-

tion. About 90 percent of the county remains in timber or is uncleared logged land. A slightly larger proportion of hardpan soils are cleared and utilized for farming than of soils with friable subsoils. The small farms are clustered in scattered settlements, principally near towns along the coast or in valleys leading to the coast.

On the basis of their dominant physical and chemical characteristics, the important soils of the county have been placed in two groups as follows: (1) Soils with cemented hardpan or bedrock substrata, and (2) soils with permeable subsoils and substrata; and the less important soils and miscellaneous land types are (3) organic soils, and (4) miscellaneous land types.

The soils underlain by cemented hardpan or bedrock substrata include soils of the Alderwood, Sinclair, Edmonds, and Melbourne series, in which drainage ranges from fair to good except in the Edmonds and Sinclair soils. The presence of hardpan arrests loss of moisture by percolation and, if the overlying soil material is not too shallow, increases the water-holding capacity of the surface soils. This is an important factor, especially during the period of low rainfall during the summer. The Alderwood and Edmonds soils, when drained, are naturally the most fertile and productive soils of this group. They occupy smooth, undulating, and gently rolling areas favorable to cultivation. Sinclair loam is a gray soil with smooth relief, which drains slowly and is more suitable for pasture and special crops than for grain crops.

Included with the second group—the soils with permeable subsoils and substrata—are the Everett, Indianola, Kitsap, and undifferentiated alluvial soils. Most of these soils have developed from materials with distinctly stratified substrata. The dominant soils are coarser textured than the hardpan soils. Their texture and permeable character promote good drainage, and in some soils drainage is excessive enough to make them droughty. The Everett and Indianola soils are inclined to be dry and require careful management in order to conserve moisture. Their naturally low water-holding capacity, together with their sandy and gravelly texture, places them on a generally low level of productivity. In contrast, the Kitsap soils, which are composed of finer particles, are free from gravel, and have more compact subsoils of better moisture-holding capacity, produce a larger quantity of general farm crops in proportion to their area than any other soil of the county.

The third group—the organic soils—is represented by small widely scattered areas of three types of peat and one of muck. They have developed through the growth, accumulation, and decay of plant remains, mixed with little or no mineral soil materials, under a high water table or under intermittently submerged marsh and swamp conditions. Their agricultural value is low, but they have some potential agricultural importance.

Of the fourth group—the miscellaneous land types—rough mountainous land and steep broken land are best suited to forestry and they afford limited pasturage. The other types have no agricultural value under present conditions.

LITERATURE CITED

(1) ANDERSON, L. L.
1936. PROFILE CHARACTERISTICS OF A WESTERN WASHINGTON SOIL. Amer. Soil Survey Assoc. Bull. 17: 170–172.
(2) DACHNOWSKI-STOKES, A. P.
1936. PEAT LAND IN THE PACIFIC COAST STATES IN RELATION TO LAND AND WATER RESOURCES. U. S. Dept. Agr. Misc. Pub. 248, 68 pp., illus.
(3) FEUSTEL, I. C., and BYERS, H. G.
1930. THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF CERTAIN AMERICAN PEAT PROFILES. U. S. Dept. Agr. Tech. Bull. 214, 27 pp., illus.
(4) KELLOGG, C. E.
1936. DEVELOPMENT AND SIGNIFICANCE OF THE GREAT SOIL GROUPS OF THE UNITED STATES. U. S. Dept. Agr. Misc. Pub. 229, 40 pp., illus.
(5) MANGUM, A. W., and party.
1912. RECONNAISSANCE SOIL SURVEY OF THE WESTERN PART OF THE PUGET SOUND BASIN, WASHINGTON. U. S. Dept. Agr., Bur. Soils Field Oper. 1910, Rept. 12: 1491–1600, illus.
(6) MARBUT, C. F.
1935. SOILS OF THE UNITED STATES. U. S. Dept. Agr. Atlas of American Agriculture, pt. 3, Advance Sheets no. 8, 98 pp., illus.
(7) WHEETING, L. C.
1936. SHOT SOILS OF WESTERN WASHINGTON. Soil Sci. 41: 35–44, illus.

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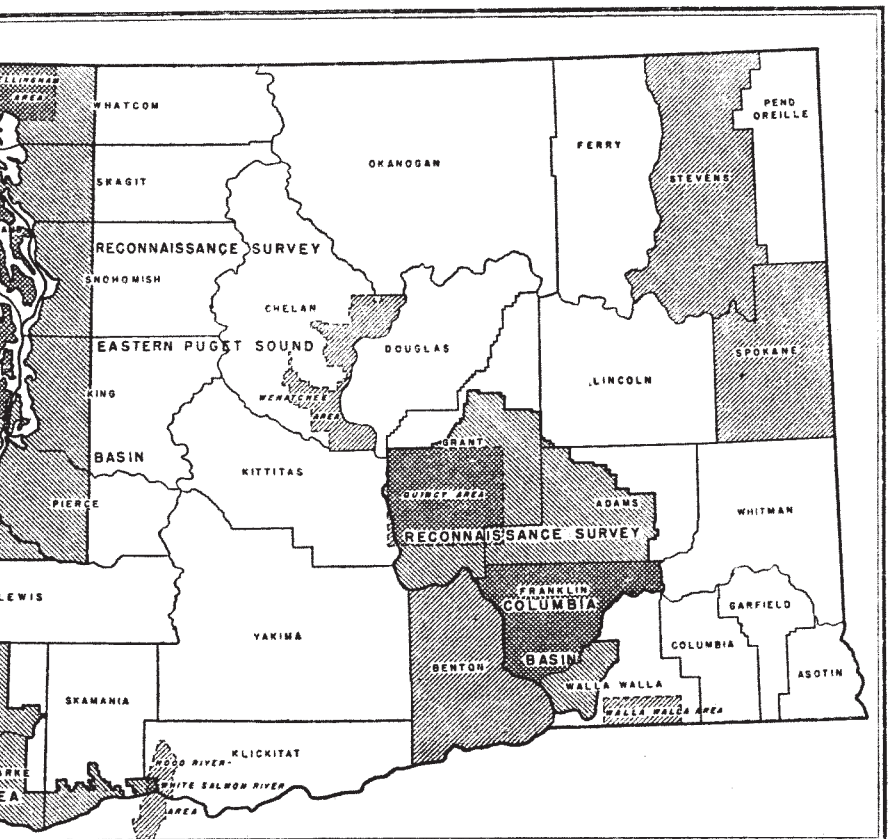

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SOIL MAP
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CULTURE
(Printed in black)

- City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort
- Secondary roads and Trails
- Railroads: Steam and Electric (DOUBLE TRACK, SINGLE TRACK, ELEVATIONS IN FEET)
- Bridges, Ferry
- R.R. crossings, Tunnel (R.R. ABOVE, R.R. BELOW)
- Ford, Dam, Sawmill, Windmill
- Boundary lines (STATE, COUNTY, CIVIL TOWNSHIP)
- School, Church, Creamery, Cemeteries
- Boundary lines (RESERVATION, LAND GRANT, CITY OR VILLAGE)
- Triangulation station, Boundary monument, Oil or Gas wells
- U.S. Township and Section lines, Recovered corners
- Forest fire station, Airway beacon, Oil or Gas tanks
- Transmission line, Oil or Gas pipe line
- Mine or Quarry, Rock outcrop, Made land
- Soil boundaries, Stony, Gravelly and Cherty areas

RELIEF
(Printed in brown or black)

- Contours, Depression contours
- Prominent hills, Mountain peaks
- Sand, Wash, and Sand dunes
- Bluff, Escarpment, Mine dumps

DRAINAGE
(Printed in blue)

- Streams, Springs, Wells, Flowing wells
- Lakes, Ponds, Intermittent lakes
- Unsurveyed and Intermittent streams
- Water-pipe lines, Canals, Ditches, Flumes
- Swamp, Salt marshes
- Submerged marsh, Tidal flats

The above signs are in common use, but all maps Horizontal Rules this twice appear in some maps of earlier dates.

LEGEND

- Alderwood loamy sand — As; Steep phase — As
- Indianola loamy sand — Is; Steep phase — Is
- Alluvial soils (undifferentiated) — A
- Coastal beach — Cb
- Alderwood fine sandy loam — Af
- Indianola fine sandy loam — Im
- Terrace phase — Cb
- Alderwood loam — Al; Steep phase — Al
- Kitsap silt loam — Ks; Steep phase — Ks
- Muck — Mu
- Greenwood peat — Gp
- Edmonds loamy sand — Es
- Imperfectly drained phase — Ks
- Rifle peat — Rp
- Edmonds fine sandy loam — Ef
- Melbourne loam — Ml
- Spalding peat — Sp
- Everett gravelly loamy sand — Eg; Steep phase — Eg
- Terrace phase — Ml
- Rough mountainous land — Rm
- Shallow phase — Ml
- Steep broken land — St
- Everett gravelly sandy loam — Ev
- Sinclair loam — Sl
- Flat phase — Ev
- Tidal marsh — T

DIAGRAM
Showing portion of county covered by reconnaissance survey

Macy H. Lapham, Inspector, District 5.
Soils surveyed by Robert Wildermuth, in charge, and S. O. Perkins, U. S. Department of Agriculture and R. E. Pasco and Edgar H. Hubbard, Washington Agricultural Experiment Station.

BASE MAP IN PART FROM U. S. COAST AND GEODETIC SURVEY CHARTS

Scale 1 inch = 1 mile
1 ½ 0 1 2 3 4 Miles

A. Hoen & Co., Inc.

Field Operations
Bureau of Chemistry and Soils
1934